ICID Addresses Global Climate Change

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Global Climate Change and Irrigation and Drainage

The average global temperature has increased by about 0.5 degrees Celsius over the past 100 years in a continuing trend toward a warmer planet. Figure 1 shows the rise in global temperatures since around 1900. Convincing evidence shows that this is the highest average global temperature in the past 600 years and evidence from tree rings and glacial ice cores suggests that the increase is unique during the last 10,000 years.

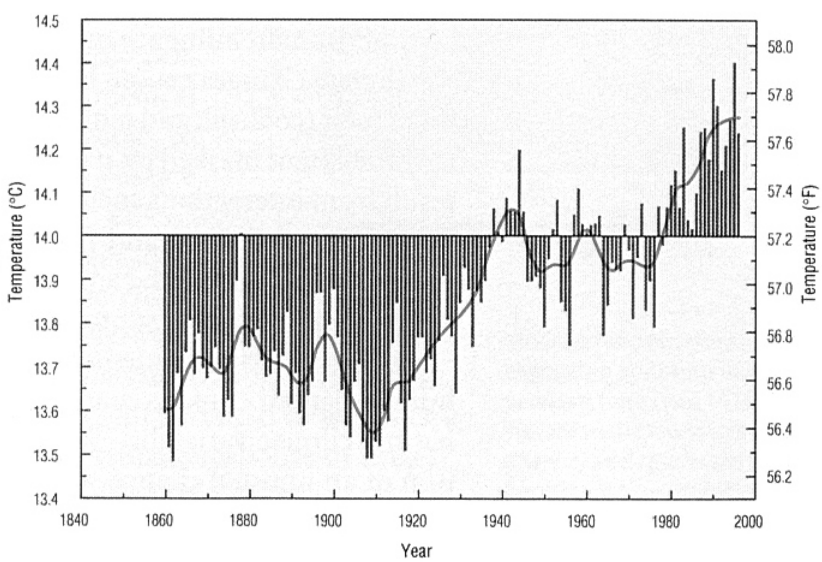

Figure 1. Measured global surface temperatures relative to the 1961-1990 average.

The heating resulting from climate change is not uniform. Temperature increases in the North American arctic have been as high as 5 degrees Celsius, and land surface temperatures have generally increased more than the global average because of the oceans' buffering effect. In addition, because winds and ocean currents redistribute the earth's heat energy and water vapor, temperature changes vary among regions. The strongest effects occur at mid and high latitudes in the northern hemisphere. Winter and spring temperatures are rising more rapidly than summer temperatures and nighttime temperatures are increasing more rapidly than daytime ones.

This warming is closely associated with rising levels of CO_2 in the atmosphere, which have increased by about 30% over the past 200 years. Increases in CO_2 levels are, is turn, associated with human activities, principally the burning of fossil fuels; coal, oil, and natural gas; and deforestation – the famous "greenhouse effect." The greenhouse effect is the result of atmospheric gasses – principally CO_2, methane, nitrous oxide, and water vapor – that trap solar energy under the mantle of the earth's atmosphere.

Projected Consequences of Climate Change to 2100

- Global temperature rises by a further 1.0 to 3.5 degrees Celsius.
- Incidence of infectious diseases increases, with malaria and other vector-borne diseases spreading into temperate regions.
- Number of people affected by coastal flooding doubles from 46 million to 92 million (more if future population increases are figured in).
- Market-oriented production of rainfed foodgrains shifts to higher latitudes.
- Agricultural pests and diseases spread and prevalence increases.
- Sea level rises by an additional 50 centimeters or more.
- Continental glaciers retreat and many disappear.

If it weren't for a naturally-occurring greenhouse effect, the earth's temperature would be about 34 degrees Celsius lower that it is – well below the freezing point. However, in the absence of human activity, the naturally produced greenhouse gases are almost exactly balanced by other natural processes which form "carbon sinks" and sequester the greenhouse gasses – principally as biomass or dissolved in seawater. The problem comes when human activity increases the production of these gasses while sequestration processes remain static. The result is increased concentrations of these gasses in the atmosphere and increased retention of incoming solar radiation, i.e. rising

Climate Change in South Africa

According to South Africa's *National Climate Change Response Strategy*, global climate change is a threat to sustainable development, especially in developing countries. The year 2005 was the warmest year on record in South Africa, and this is bad news for a country which already has a high-risk hydroclimatic environment, with low rainfall-to-runoff conversion and a high inter-annual variability of climate. The country anticipates that it may even face the need to re-negotiate its international water agreements with its neighbours, with whom it shares 70% of its water resources.

Of particular concern is the impact of GCC on the most vulnerable communities, as these are invariably the least well-equipped to deal with such widespread change. As Minister of Agriculture Thoko Didiza puts it, "Climate change is a serious risk to poverty reduction and threatens to undo decades of development effects."

The Water Wheel, Jan/Feb 2006

global temperatures. The burning of fossil fuels accounts for 80 to 85 percent of human-caused CO_2 emissions, while land use changes account for 15 to 20 percent.

The reports of the Intergovernmental Panel on Climate Change[1] (IPCC) allow little doubt as to the cause and effect relationship between human-induced increases in atmospheric CO_2 and the rise in global temperatures. And the persistence of CO_2 in the atmosphere means that even if anthropogenic CO_2 emissions were to cease tomorrow, global temperatures would continue to rise for centuries.

In addition to its direct effects, rising global temperatures set in motion a series of other events that will be unevenly distributed across the globe. Of particular interest to irrigation and drainage professionals are those which affect precipitation, soil moisture status, river hydrology, droughts, flooding and agricultural crop growth. Some of these are the following.

Changes in precipitation patterns. In general, rising temperatures lead to increased evaporation and increase the moisture-holding capacity of the atmosphere, which in turn should lead to increased precipitation. Precipitation will be unevenly distributed though, and some areas will receive more precipitation than at present and others less. In mid and upper latitudes, there will be changes in the mix of snow and rain, with more precipitation falling as rain as temperatures rise. Models also predict increased variability in precipitation, and more extreme events – increased flooding and more intense droughts.

Increased storage losses. Water stored in lakes and reservoirs will suffer increased losses due to evaporation, reducing the water available for irrigation, municipal supplies, and all other uses. Moreover, more intense precipitation events may enhance erosion in watersheds above reservoirs, increasing sediment deposition and reducing storage capacity.

Reduced storage of precipitation as snow. Higher temperatures at elevations where snow accumulates as snowpack to be released during spring and summer months will mean that runoff occurs earlier, either during the precipitation events themselves, or sooner in the melting period. This can exacerbate winter and spring flooding and reduce river flows during times of peak water demand. This is an important issue in temperate region countries like Chile, Australia, the United States, and Canada, and also in nations watered by major rivers originating in the Himalayas, such as India, Pakistan, Nepal, Bangladesh, Burma, and China.

Increased crop water demands. Higher temperatures will increase transpiration from vegetation, boosting water requirements for both rainfed and irrigated crops. At the same time, increased biomass production due to higher temperatures and elevated CO_2 levels in the atmosphere will tend to increase yields. These factors will interact in complex ways.

Rising sea levels. The melting of polar glaciers and thermal expansion of seawater in response to rising temperatures are increasing the volume of oceans, raising sea levels. Since the end of the 19th century, measured sea level increases have averaged 1 to 2

[1] An intergovernmental scientific panel of more than 2,000 scientists, established in 1988 by the United Nations Environmental Program (UNEP) and the World Meteorological Organization (WMO).

mm/year and now total 10 to 25 cm. As temperatures, and sea levels, continue to rise, this effect will inundate low-lying coastal areas, increase coastal damage due to storm surges, and increase the saline water intrusion into vulnerable freshwater aquifers along the coast. The overall effect will be to reduce the extent of coastal agricultural lands, especially paddylands, force some coastal populations to migrate inland onto currently cultivated land, and reduce fresh groundwater availability.

These consequences of GCC suggest some important and interesting questions for irrigation and drainage professionals. Among them:

- How can reservoir operations be modified to account for higher storage losses, more extreme events, and other expected changes?
- How will higher temperatures, increased CO_2 concentrations, and reduced soil moisture levels combine to affect crop yields and crop water requirements?
- What is the scope for stabilizing rainfed yields through supplemental irrigation in areas where precipitation declines and becomes more variable?
- What is the likely impact of particular shifts in precipitation patterns on groundwater recharge and availability?
- How can new and remodelled infrastructure help to adapt irrigation systems to the disruptions caused by GCC?
- What are policy and institutional requirements for management strategies that cope successfully with GCC-induced changes?

These and other questions are ones that can be addressed by a newly-formed ICID Working Group.

Working Group on Global Climate Change

In its meeting in Beijing in September 2005, the IEC accepted the recommendation of the Technical Activities Committee to establish a Working Group on Global Climate Change (WG-Climate). Vice President Mark Svendsen (USA) was named acting chairman of the working group. To date 8 national committees (Egypt, India, Italy, Japan, Netherlands, the Philippines, South Africa, and the United States) have named representatives to the WG, and three international organizations (IFPRI, IWMI, and the WMO) have named observers to participate.

The purpose of WG-Climate is to:

1. Raise awareness and stimulate discussion among national committees, policy makers, and the general public on the implications of GCC for irrigation, drainage, and flood control.
2. Share and collect experience with GCC and its water-related implications
3. Position ICID to play a role in ongoing discussions of GCC effects related to irrigation, drainage, and flood control.

The work of the WG will center around annual seminars where information on GCC and its implications will be shared and discussed. These will take place during the annual

IEC meetings and their associated conferences – Kuala Lumpur in 2006, Sacramento in 2007, and Lahore in 2008. The WG will aim to accomplish its purpose, as stated above, by 2008, and will decide at that time if the group should continue to work for an additional three-year period.

The meetings of the WG will comprise a brief business meeting to confirm membership and select leaders and a seminar consisting of paper presentations and discussions. Seminars will be open to all interested participants. Presentations will consist of both invited and contributed papers from both national representatives and observers. A half-day meeting/seminar is tentatively planned for Kuala Lumpur, with the possibility of full-day seminars in subsequent years, depending on interest.

Outputs from the WG will include a website, on which all contributed papers will be posted, together with links to the extensive set of resource materials available on other sites. During the second annual meeting in Sacramento, the WG will consider what other outputs may be warranted and useful.