Floods may be the norm

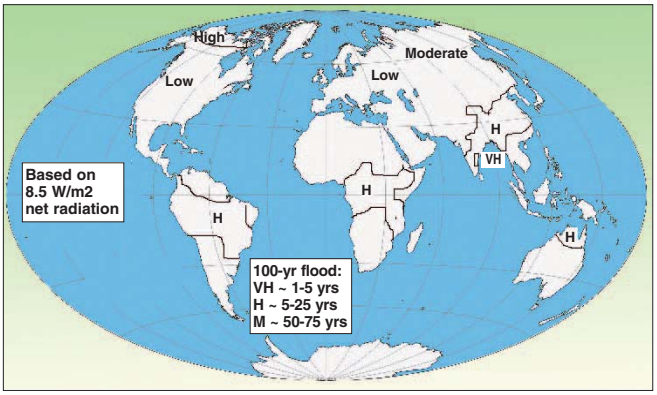
Global warming may call for great intervention in the flow of rivers, says S ANANTHANARAYANAN

THE recent disaster in Uttarkhand has led to much criticism of agencies that are said to have promoted the silting of rivers and the need for mini-hydel projects in the area have been questioned. But 60 hours of heavy rainfall and continued discharge from the glacier sources of the Bhagirathi and the Alaknanda may not have been contained in any case. A wider understanding of the drivers of climate, which would make such situations more frequent in the coming decades, may help press in vital adaptation measures that many regions in the world need to undertake.

Yukiko Hirabayashi, Roobavannan Mahendran, Sujan Koirala, Lisako Konoshima, Dai Yamazaki, SatoshiWatanabe, Hyungjun Kim and Shinjiro Kanae from institutes in Tokyo and the University of Bristol, UK, report in the journal *Nature Climate Change* their analysis, for the first time, of the data in 11 different climate change models, which concludes that Southeast Asia, peninsular India, eastern Africa and the northern half of the Andes would see a large increase in flood frequency. This finding contrasts the results of different, standalone studies, whose forecasts are similar but reserve a wide margin for error.

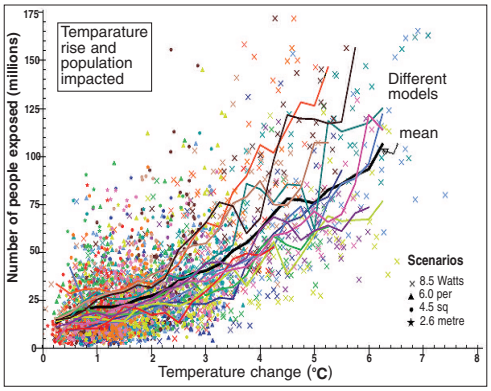
As easily the gravest climate related disaster there is, floods are a public concern that deserves cooperative international address. In 1988, two United Nations organisations, the World Meteorological Organisation and the UN Environment Programme, set up the Intergovernmental Panel on Climate Change, a multinational, scientific inter-governmental body representing more than 120 countries and chaired by Rajendra K Pachauri of India. The IPCC compiles reports and research carried out the world over and serves as an internationally recognised advisory body. Although it shared the 2007 Nobel Peace Prize with Al Gore, much of its advice has gone unheeded.

The methodology of making forecasts of flood risk is through assessing the dynamics of evaporation, winds and precipitation, in what is called the *Atmosphere-Ocean General Circulation Model*. Making use of daily river discharge data and other meteorological information that is publicly available, some of the models have factored in the expected warming of the world. But the data needed, like daily runoff, is typically not easily available and the studies have had to make to do with what they could get. The IPCC *Special Report on Extremes* said, "Overall, there is low confidence in projections of changes in fluvial floods. Confidence is low due to limited evidence and because the causes of regional changes are complex."



In the study now reported, outputs of the latest 11 Atmosphere-Ocean General Circulation Models were made use of to work out a worldwide projection of changes in flooding. Daily runoff data of AOGCM simulations that were used include historical simulations (1850-2005), forced by natural causes like volcanic and solar effects, and man-made, like greenhouse gases and ozone, and future simulations (2006-2100) based on different projected greenhouse gas concentration levels. The future simulations consider a range of net warming of the earth by the sun, from a low, 2.6 watts to a high 8.5 watts for every square metre in 2100.

The object of the study was to assess the change in the chances of a particular level of river discharge in 2000 and in 2100. The river discharge equal to the 100-year maximum was chosen as the particular level. Using simulations for the periods 1971-2000, the level of river discharge which was the 100-year flood in 2000 was worked out for each location. Simulations for the period 2071-2100 were then carried out to assess how often the same levels would be reached in 2100. The findings, shown in the picture, are that in southeast Asia, the Indian peninsula, eastern Africa and northern South America, the 100-year maxima of 2000, can be expected every five to 25 years. And in one part of southeast India, this would happen every two to five years!



The study followed through with analyses of the impact of the high flood frequency after taking into account the population affected. The higher frequency of floods in southern latitudes, which have a high population, would accentuate the human impact. This becomes sharper with the projected increase in population during the rest of the century. The next analysis done was to connect projected rise in global temperature with the population affected by floods. The estimated populations affected, in 2010, without accounting for population rise, was compared with respect to levels of warming. The results show dramatic increases in the numbers affected and should act to bring home the need for fixing demanding targets for greenhouse gas control.

"Despite the limitations in our methodology and inevitable uncertainty in regional and basin-scale projections, the results of this study signify the necessity for adequate adaptation and mitigation strategies on a global scale: adaptation to intensified floods and mitigation of greenhouse gas emissions. Major attention should be paid to lower-latitude countries where flood frequency and population are both projected to increase," say the authors in the paper.

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The need for managing consumption

Given the climatic havoc to which energy production has been a key factor, SADIQ MOHAMMED **puts the Home Area Networks into perspective**

THE energy problem facing humankind is real and encompasses inadequate supply, excess demand, global warming and the growing carbon footprint, which is strongly believed to have impacted weather patterns globally. The world is warming, El Niño and El Niña are for real and we have experienced this in the recent past (hurricanes Sandy and Katrina).

Given the climatic havoc, to which energy production has been a key factor, the need to manage production and consumption is urgent. Traditionally, the commercial and industrial sectors have been in the focus for energy consumption and conservation. The focus now is shifting to the retail segment, largely of home energy users, which, in some developed countries with a low manufacturing base, is as high as 80 per cent. Most utilities (your energy provider) have Contractual Demand Management programmes for industrial customers to reduce consumption at peak demand hours so as to reduce the risk of a grid collapse and major outage (as in the case of the US Northern Grid) when demand exceeds supply.

The utilities are now shifting their gaze towards the residential customer, as it is a very large percentage of the total user base. Education of the customer and creating awareness will push the success of larger energy management programmes, which will truly have the customer tuned in to energy conservation and utilities to better manage the supply during peak demand.

To be able to conserve energy, with the least discomfort for residential customers and the lowest impact to businesses, the answer is evolving in Home Area Networks and Building Area Networks. With these technologies, you can switch of an appliance on demand, leading the way to better energy demand and supply management.

Why, then, the lethargy? There are some realities we must contend with, namely:

- Do we need more energy-efficient appliances? This is a paradox of a problem; there is less focus here, and in the past 20 years energy efficiency in appliances has traversed this space very slowly.

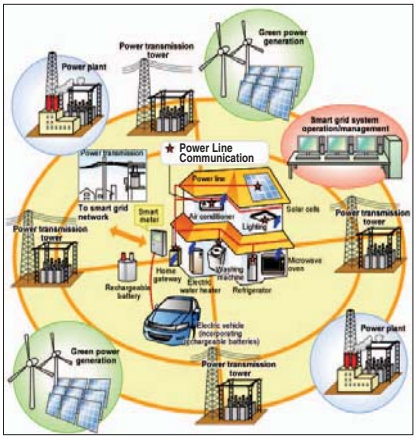
The good news is you will consume about 40 per cent less on an appliance bought a year ago, compared to the one that is 10 years older. Since 2000, energy start benefits have tripled.

- The small appliance is beginning to make an impact: The demand for energy from smaller appliances is growing at a much faster rate. Between 1976-1995, this grew at a rate of 4.6 per cent and it was projected to grow 50 per cent between 1996-2010, which will equal about 1,000 TWh (or 10-15 large power plants). Twenty per cent of this will be through energy leakage, which, by itself, will have the potential to save a dollar.
- Customer education is the key ingredient. This is the biggest gap that is holding back residential customer participation in energy management and conservation. The utilities are beginning to refocus on customer awareness and reach-out programmes are on the anvil for larger participation in energy management.

How can Han help to conserve energy? It provides the homeowner with the capability of remotely switching on/off; delaying, starting and, most of all, responding better to and participating in utility signals during peak loads to conserve energy.

Who will pay? The utility or the homeowner? This brings us to a perennial problem and is kind of the chicken-and-egg story. Unless there is a proven value/benefits model, the homeowner is not buying it.

As for security concerns on exposure to private customer data, this is a biggie for privacy advocates. Usage patterns, hacking into Home Area Networks are some of the reasons holding back the adoption of Han deployment. Still, the concept today has an esoteric appeal to the geek and the do-it-yourself enthusiast, even if mass appeal is some way off.



Han and Ban are critical components in our journey towards managing our energy management and conservation programmes.

Their adoption life cycle is in the "early adopters/innovators" space; and growth based on current trends is likely another five years away. There is no doubt that Han will be the future of home management and energy conservation. Already homebuilders in the USA are adopting Han components in the high-end segment.

A potential driver that is believed to lead the way is home security. The concern for protecting the "castle" will take on an urgency. The ability to be able to remotely open doors or receive alarms for intrusion and quickly and adequately act upon an event will become a necessity. Home security along with protection of personal property, given all things being equal, is most likely to usher in Han.

The germination of the idea has begun. The other aspect that is encouraging is the awareness of climatic damage we have created and the need to take positive steps to control the damage and that is becoming a beacon to follow for a segment of homeowners and businesses. All this is good news. Convenience, security standards, ease of use and cost will be the prime drivers to usher in the change in perspective and adoption.

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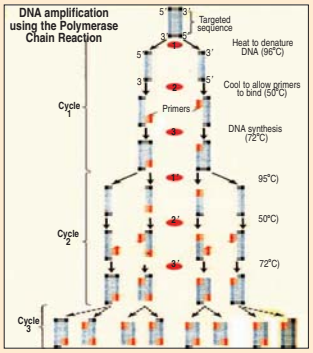
Extremely valuable

TAPAN KUMAR MAITRA explains the process of Polymerase Chain Reaction

THE ability to work with minuscule amounts of DNA is proving valuable in a wide range of endeavours ranging from paleontology to criminology. DNA fingerprinting analysis can be used to identify and characterise particular sequences contained in as little as one mg of DNA, the amount in a small drop of blood, but sometimes even this amount may not be available. In such cases, another method called the Polymerase Chain Reaction can come to the rescue. With PCR, it is possible to rapidly replicate, or amplify, selected DNA segments that are initially present in extremely small amounts. In only a few hours, PCR can make millions or even billions of copies of a particular DNA sequence, thereby producing enough material for DNA fingerprinting, sequencing, or other uses. Like DNA fingerprinting, PCR is often in the news in connection with solving violent crimes.

The complicated multi-protein system that cells use for DNA replication is not required for the PCR method; neither origins of replication nor DNA unwinding proteins nor the apparatus for lagging-strand synthesis are involved. The keys to the simplicity of PCR are an unusual DNA polymerase and the fact that synthetic primers can set up a chain reaction that produces an exponentially growing population of specific DNA molecules. For this insight, biochemist Kary Mullis received a Nobel Prize.

To carry out PCR, it is usually necessary to know part of the base sequence of the DNA segment that one wishes to amplify. Based on this information, short single-stranded DNA primers are chemically synthesised; these primers are generally 15-20 nucleotides long and consist of sequences that are complementary to sequences located at the two ends of the DNA segment being amplified. (If sequences that naturally flank the sequence of interest are not known, artificial ones can be attached prior to running the polymerase chain reaction.) DNA polymerase is then added to catalyse the synthesis of complementary DNA strands using the two primers as starting points. The DNA polymerase routinely used for this purpose was first isolated from the bacterium *Thermus aquaticus*, an inhabitant of thermal hot springs where the waters are normally 70°-80° Celsius. The optimal temperature for this enzyme, called *Taq polymerase*, is 72° Celsius, and it is stable at even higher temperatures — a property that made possible the automation of PCR.



The ingredients of the initial reaction mixture include the DNA containing the sequence targeted for amplification, Taq DNA polymerase, the synthetic DNA primers, and the four deoxynucleoside triphosphates (dATP, dTTP, dCTP and dGTP). Each reaction cycle begins with a short period of heating to near boiling (95° Celsius) to denature the DNA double helix into its two strands (1). The DNA solution is then cooled to allow the primers to bind to complementary regions on the DNA strands being copied (2). The temperature is then raised to 72° Celsius and the Taq DNA polymerase goes to work, adding nucleotides to the 3' end of the primer (3). The specificity of the primers ensures the selective copying of the stretches of template DNA downstream from the primers. It takes no more than a few minutes for the Taq polymerase to completely copy the targeted DNA sequence, thereby doubling the amount of DNA. The reaction mixture is then heated again to melt the new double helices, more primer is bound to the DNA and the cycle is repeated to double the amount of DNA again (-3').

This reaction cycle is repeated as many times as necessary, with each cycle doubling the amount of DNA from the previous cycle. After the third cycle, more and more of the product DNA molecules will be of a uniform length that consists only of the targeted sequence (like the third and sixth molecules in the last line of the fiigure). Because heating to 95° Celsius does not destroy the Taq polymerase, there is no need to add fresh enzyme for each round of the cycle. In most cases, 20-30 reaction cycles are sufficient to produce the desired quantity of DNA.

PCR, therefore, makes it possible to identify a person from the minuscule amount of DNA that is left behind when that person touches an object, inadvertently leaving a few skin cells behind. By using PCR to amplify the tiny amount of DNA in such a sample and then performing a fingerprinting analysis on the amplified DNA, it is possible to obtain a fingerprint from a person's actual fingerprints! Although such techniques have enormous potential in helping to solve crimes, this extraordinary sensitivity can also cause problems. A few contaminating DNA molecules (such as from skin cells shed by a lab technician) might be amplified along with the DNA of interest, yielding misleading results. In a legal case, such an error could lead to grave injustice and for this reason courts are proceeding cautiously in allowing the introduction of PCR evidence.

Nevertheless, with proper precautions and controls, PCR is proving extremely valuable. As an aid in evolution research, it has been used to amplify DNA fragments recovered from ancient Egyptian mummies, a 40,000-year-old woolly mammoth frozen in a glacier and a 30-million-year-old plant fossil. In medical diagnosis, PCR has been used to amplify DNA from single embryonic cells for rapid prenatal diagnosis, and it has made possible the detection of viral genes in cells infected with HIV or other viruses. Perhaps most importantly, PCR has revolutionized basic research in molecular genetics by allowing easy amplification of particular genes or sequences from among the thousands of genes in mammalian genomes.

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