

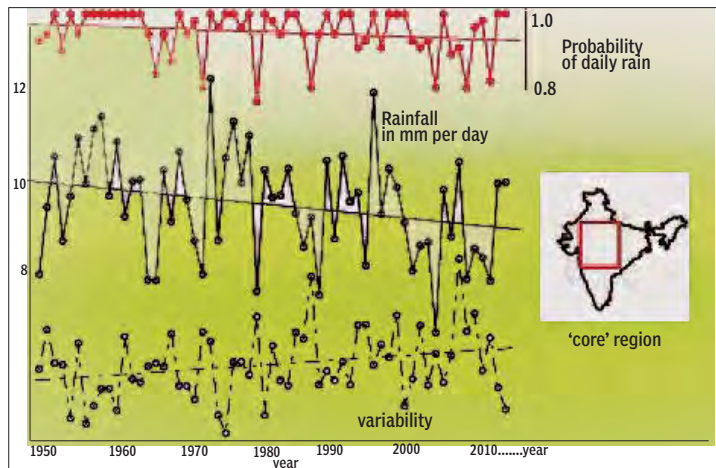
# More dry days ahead

THE INDIAN SUMMER MONSOON IS FOUND TO HAVE DECREASED IN INTENSITY WITH AN INCREASED VARIATION OF WET AND DRY SPELLS OVER 60 YEARS, SAYS S ANANTHANARAYANAN

The last century has seen great changes, and an awareness of the changes, in world climate. As a subject of great complexity, it takes wide data collection and rigorous statistical analysis to help manage the impact of changing weather conditions. The Indian monsoon affects large numbers of lives and measures to deal with events of heavy downpours or prolonged dry spells would have huge economic value.

Scientists Deepti Singh, Michael Tsiang, Bala Rajaratnam and Noah S Diffenbaugh at Stanford University report in the journal *Nature Climate Change* that a comprehensive statistical analysis of data from 1951 to 2011 reveals falling overall rainfall, with more variable daily rainfall and changes in frequency and intensity of wet and dry spells in the core monsoon region of India. "The observed changes in wet and dry extremes during the monsoon season are relevant for managing climate-related risks, with particular relevance for water resources, agriculture, disaster preparedness and infrastructure planning," the authors of the paper say.

India receives 85 per cent of annual rainfall during the summer monsoon. Dry spells during critical periods of soil preparation or crop growth during the monsoon or in the winter crop season could, hence, wreck agriculture, which forms the mainstay of employment and sustenance of most Indians, apart from being the base for a large part of the country's exports. Intense periods of rainfall could similarly lead to disasters, as in the 2005 Mumbai



downpour or last year's flooding in Uttarakhand. With changing conditions, particularly from global warming, climate extremes are likely to intensify. Hence the importance of comprehensive analyses of available data to identify changing trends and then the underlying factors.

It is by analyzing data of temperature, humidity and wind speed over wide areas

that climate trends that were barely discernable have been studied, including the identification of global warming. Although former US Vice-President Al Gore got the Nobel Peace Prize for his work on global warming, the issue has been studied for over a century. While Swedish scientist Svante Arrhenius had sug-

gested in 1896 that burning fossil fuels would increase the CO<sub>2</sub> content of the atmosphere and lead to warming, it was in the 1930s, by detailed data collection, that it was realised that the USA and the North Atlantic had warmed significantly over the previous 50 years. This was initially dismissed as some mild, natural cycle, but one voice, of an amateur; GS Callendar, said it was the greenhouse effect. During the 1950s, with increased government funding, scientists looked at this idea with better instruments and techniques and, in 1960, CD Keeling was able to show, after painstaking measurements, that the warming was due to CO<sub>2</sub> build-up, which was increasing every year.

Climate change was intensely studied over the following decades and there were conflicting findings, either genuine or motivated, of these changes having been the trend since millennia of the dust levels caused by human activity that was causing shading and global cooling, rather than warming, etc. But data has collected and it is firmly established now that it is the CO<sub>2</sub> arising from human activity that is building up, with a distinct rise in global temperature. Complex modelling and com-

puter simulation have now predicted varying estimates, of two, three and four degrees Celsius as the rise in temperature by the end of the century, with different effects on sea levels, humidity, winds and rainfall. But common consensus is that weather is a complex subject.

## Stanford group study

Central India receives a high average rainfall during the monsoon season, July-August, with frequent "wet" spells of intense rain, or "dry" spells of no rain. The Stanford University group used rigorous statistical methods to evaluate whether the trend of extreme wet and dry spell characteristics had changed between the 1851-1980 and 1981-2011 periods.

The data used was from the Indian Meteorological Department record of daily rainfall, which is developed from some 2,140 rain gauge stations distributed over the core monsoon region in the Indian subcontinent. The "active spells" or intense periods and the dry spells or "breaks" are associated with the location of a convergence of conditions of atmospheric conditions, particularly air movement at and on either side of boundary layers, which bring about anomalies. Analysis of the data had, thus, to employ techniques to eliminate anomalies and the result has shown a fall in the average rainfall, over the 60-year period, despite increased moisture content of the atmosphere due to warming.

At the same time, the data shows a rising trend of variability of daily rainfall. The findings are consistent with a falling probability of rain every day, which is computed as the fraction of the days when there was at least one millimeter of rainfall, as well as the higher variability in the intensity of the rain. In addition, a reduction of two millimetres per day in the peak rainfall has been noted over the 1980-2011 period.

While the fall in average rainfall has already been observed and explained in different ways, the present study is the first that has looked carefully at the record of wet and dry spells. The present analysis takes elaborate care to eliminate the effects of seasonal variations and changes in climate over the decades and concludes that the trend is towards more intense wet spells and more frequent but less intense dry spells.

"Given the heavy dependence of agriculture on rainfall and the acute human vulnerability to flood events, the increases in dry spell frequency and wet spell intensity identified in our results represent increasing climate-related risks in the Indian subcontinent," the authors of the paper say. Population growth, land use change and groundwater depletion would aggravate risks. Although there are environmental changes that are associated with the trends identified, the underlying reasons for these trends need to be discovered to manage "evolving risks of extreme wet and dry events", the authors say.

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## PLUS POINTS

### Feeding frenzy

In tropical forests, as many as 1,000 insects can live together on the same flower. Using molecular techniques, researchers have attempted to understand the interaction between communities of



A female fly sitting on male flowers of a plant belonging to the genus *Gurania*.

plant-eating insects that live in flowers and parasitic wasps (parasitoids) that lay eggs in the insect larvae. The results show that interactions between plants, flies and wasps happen across three levels of the food chain and create a multitude of tiny habitats, each with its own specialised resident insects.

The research, which took place at Los Amigos Biological Station in Peruvian Amazon, looked at two species of the genus *Gurania*. These climbers are a relative of the cucumber. At the base of each flower of these plants, up to 1,000 larvae from 14 species of the peacock fly belonging to genus *Blepharoneura* were found. Most species were restricted to male or female flowers of their chosen plant. It was also found that wasps of three different genera had sneaked up to the unsuspecting peacock fly larvae and laid eggs inside them. These parasitic wasps develop inside the host insect. The peacock fly larva continues its life, munching the flower till it forms a puparium — its outer covering hardens to form a safety vault inside which the fly sleeps its way to adulthood. The parasitic wasp larva comes out of the egg, inside the puparium, and feeds on the fly larva, eventually killing it, and transforms into a full grown wasp.

The researchers collected about 1,500 puparia from more than 3,600 flowers of the two species of *Gurania*. To identify the flies, the authors matched the sequence of a gene found in the mitochondria to existing databases. Using the physical appearance of the parasitic wasps, three different molecular diagnostic tools and genetic studies, the authors could tease apart 18 parasitic wasp species. "We were totally amazed by this number. Blown away," says Marty Condon, lead author of the study and associate professor of biology at Cornell College, USA. The study was published in *Science*.

SANDHYA SEKAR/CSE-DOWN TO EARTH FEATURE SERVICE

### Vampire therapy

It sounds like the stuff of vampire movies, but scientists have shown that an infusion of young blood can reverse signs of ageing. Although the ghoulish experiment was conducted on laboratory mice, the next step could involve a study of elderly humans. The researchers believe young blood may contain natural chemicals that turn back the clock to rejuvenate the ageing brain.

In the study, blood from three-month-old mice was repeatedly injected into 18-month-old mice near the end of their natural life span. The "vampire therapy" improved the performance of the elderly mice in memory and learning tasks. Structural, molecular and functional changes were also seen in their brains. Writing in the journal *Nature Medicine*, the US team led by Dr Tony Wyss-Coray, from Stanford University, said, "Our data indicate that exposure of aged mice to young blood late in life is capable of rejuvenating synaptic plasticity and improving cognitive function. Future studies are warranted in aged humans and potentially those suffering from age-related neuro-degenerative disorders."



Evidence was seen of new connections forming in the hippocampus, a brain region vital to memory and sensitive to ageing. Ageing mice given eight infusions of young blood over three weeks improved their performance in mental tests. Infusions of blood from other elderly mice had no effect.

What caused the changes is still unknown, but it appears to involve activation of a protein called Creb in the hippocampus that helps regulate certain genes. The scientists wrote, "One possibility is that introducing 'pro-youthful' factors from aged blood can reverse age-related impairments in the brain, and a second possibility is that abrogating pro-ageing factors from aged blood can counteract such impairments. These two possibilities are not mutually exclusive, warrant further investigation, and may each provide a successful strategy to combat the effects of ageing." Dr Eric Karran, from the dementia charity Alzheimer's Research UK, described the results as "interesting", but added that the study "does not investigate the type of cognitive impairment that is seen in Alzheimer's disease".

JOHN VON RADOWITZ

## A COMPLEX SUBSTRATE

TAPAN KUMAR MAITRA PRESENTS THE LOWDOWN OF SOIL MICROFLORA

Soil fertility depends not only on the presence of inorganic and organic substances but also on the presence of various species of micro-organisms that influence the qualitative composition of the soil. Due to nutrients and moisture, the number of microbes in one gram of soil reaches a colossal number — from 200 million bacteria in clayey soil to 5,000 million in black soil. One gram of the ploughed layer of soil contains 1,000-10,000 million bacteria.

Soil microflora consists of algae, nitrifying, nitrogen-fixing, denitrifying, cellulose-splitting and sulphur bacteria, pigmented microbes, fungi, protozoa, etc. The blue-green algae play an important part in enriching the soil with nitrogen. The extent to which soil is contaminated with microbes depends on its nature and chemical composition.

The greatest amount of microbes (one million per cubic centimetre) is found in the top layer of soil at a depth of five-15 cm. In deeper layers (1.5-five metres) individual microbes are found. However, these have been discovered at a depth of 17.5 metres in coal, oil and artesian water.

Oil bacteria live in oilwells. Using paraffins (distillates of oil) as nutrients, they turn part of the oil into a thick asphalt-like mass with the formation of which

natural oil reservoirs become clogged. It has been calculated that in the ploughed layer of cultivated soil over an area of one hectare there may be from five to six tons of microbial mass.

The number of micro-organisms in soil depends on the extent of contamination with faeces and urine, and also on the nature of treating and fertilising the soil. For example, ploughed soil contains 2.5 times more microbes than forest soil. Saprophytic spores (*B. cereus*, *B. megaterium*, etc) survive for long periods in soil. Pathogenic bacteria that do not produce spores due to lack of essential nutrients, and also as a result of the lethal activity of light, drying, antagonistic microbes and phages do not live long in soil (from a few days to a few months).

Usually, soil is an unfavourable habitat for most pathogenic species of bacteria, rickettsiae, viruses, fungi and protozoa. However, soil as a factor of transmitting a number of causative agents of infectious diseases is quite a complex substrate. Thus, for example, anthrax bacilli, after falling on the soil, produce spores that can remain viable for many years. In favourable conditions (in dark brown soil and chernozem), these pass through the whole cycle of development: during the summer months the spores germinate into vegetative forms and then this cycle

is repeated.

The spores of *Clostridia*-causing tetanus, anaerobic infections and botulism, and of many soil microbes, survive for long periods in soil, which is the habitat for various animals (rodents) that are parasitised by the carriers of the causative agents of plague, tularemia, the viruses of mosquito fever, haemorrhagic fever, encephalitis, agricultural leishmaniasis, etc. The cysts of intestinal protozoa (amoeba, balantidium, etc) spend a certain stage in soil, which plays an important role in transmitting worm invasions (ascarids, hookworms, nematode worms, etc). Some fungi live in soil. Entering the body, they cause fusariosis, ergotism, aspergillosis, penicilliosis, mucormycosis, etc.

Taking into consideration the definite epidemiological role played by soil in spreading some infectious diseases of animals and man, a sanitary-epidemiological practice involves measures directed at protecting soil from pollution and infection with pathogenic species of micro-organisms.

Soil scientists have devised a method of investigating soil microbes and used the results obtained in agriculture. A valuable index of the sanitary condition of soil is the discovery of the colibacillus and related bacteria, also enterococci and *Clostridium perfringens*.

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## 'Like a bottle on a slant'

EAST ANTARCTICA MELT COULD CAUSE A GLOBAL COASTAL DESTRUCTION. STEVE CONNOR REPORTS

Parts of the vast ice sheet of East Antarctica — which collectively holds enough water to raise global sea levels by 53 metres — could begin an irreversible slide into the sea this century, causing an unstoppable process of global coastal destruction, scientists have warned.

East Antarctica is widely considered to be more stable than the West Antarctic ice sheet but a study suggests that a large region of the eastern ice sheet is in danger of becoming irreversibly unstable once a relatively thin section of retaining ice on its coast is lost, researchers said. A slab of coastal ice is all that is stopping the giant Wilkes Basin ice sheet from slipping into the sea. Once this process begins, it will relentlessly continue to pour vast amounts of water into the oceans for centuries to come, raising global sea levels by between three and four metres, they said.

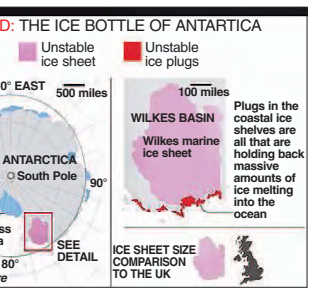
"East Antarctica's Wilkes Basin is like a bottle on a slant and once uncorked it empties out," said Matthias Mengel of the Potsdam Institute for Climate Research in Germany, and lead author of the study published in the journal *Nature Climate Change*. "The East Antarctic ice sheet has long been considered to be stable even under a warmer climate, in contrast to its West Antarctic counterpart. We have now shown that this may not be true," he said.

"This implies that the future sea-level contribution of the East Antarctic ice sheet may be significantly higher than previously estimated. This is important for the millions of people who live on the coasts. Every centimetre of sea level rise on top of what is already expected is going to be even more difficult to adapt to. By emitting more and more greenhouse gases, we might trigger responses now that we may not be able to stop in the future."

East Antarctica holds about 10 times the volume of ice than its smaller West Antarctic cousin. Much of the ice in the east lies at high altitude and is kept well below freezing point, but a large proportion of it — enough to raise sea levels by 19 metres — lies on bedrock that is below sea level, such as the Wilkes Basin. Scientists had considered even this low-lying part of the East Antarctic ice sheet — the so-called marine ice sheet — to be more stable and less likely of disintegrating in a warmer climate than the marine ice sheet of the West Antarctic.

However, the analysis of the underlying bedrock on which the marine ice sheet of Wilkes Basin stands suggests

this is not the case. The scientists found that the rock, which is below sea level and therefore more vulnerable to climate change, becomes a raised ridge at the coast which allows the ice to form a protective plug between the ocean and the ice sheet on the land behind it. Computer mod-



elling shows that if the local ocean temperatures around the East Antarctic rise as a result of global warming, the ice plug will continue to melt to a point where the "bottle" of ice held within the Wilkes Basin becomes "uncorked".

"Once started, it becomes unstoppable. At the moment it's still stable but if it melts then the ice plug alone will result in a global sea level rise of between five and eight centimetres, but the ice that it will release is going to cause 80 times that amount of sea-level rise," said Professor Anders Levermann of the Potsdam Institute. "The bottle is so much bigger than the cork and these plugs of ice on the coast are so much smaller than the ice that they are keeping in place."

The Intergovernmental Panel on Climate Change said that estimating future sea level rise was one of the most difficult areas to predict, partly because of the unknown effects in the Antarctic. In its last report, published in March, the IPCC said that Antarctica's total sea level contribution would be up to 16 cm this century, but if half of this ice loss occurred in the ice-cork region, the irreversible discharge of Wilkes Basin ice into the sea would begin, Professor Levermann said. "Unfortunately, we don't know whether we've initiated this process yet. It's fair to say that if we continue unmitigated climate change and global warming, then we'll destabilise parts of Antarctica and trigger a discharge of ice that will not stop for centuries."

"It may not be an imminent threat but it will change the planet and will have an impact on global culture because of the huge loss of the cultural heritage of the people living near the coasts," he added.

