

Forecasting the cloudburst

Extreme climate events have been happening more often, but we could hope to get early warning

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Loss and destruction by floods and heavy rains may not be unusual in India, but sudden downpours that paralyse whole districts appear to have become frequent. Each year gives us instances that are worse than those of previous years and this trend, of growing extreme events, has been underlined by the IPCC, by writers and researchers.

MK Roxy, Subimal Ghosh, Amey Pathak, R Athulya, Milind Mujumdar, Raghun Murtugudde, Pascal Terray and M Rajeevan, at the Institute for Tropical Meteorology, Pune, IIT-Mumbai, at Kochi, University of Maryland, the Sorbonne and the Ministry, Government of India, report in the journal, *Nature Communications*, a study of how extreme events are increasing despite falling average rainfall. The study discovers features that could help forecast these events as early as two to three weeks before they occur.

The losses caused by floods that are attributed to extreme rainfall events in India, during the last decade, were about \$ 3 billion a year, which is a whole 10 per cent of the losses worldwide, the paper says. There were 268 flooding events reported in India during the 65 years from 1950 to 2015, affecting 825 million people, and a good part of the flooding events took place over central India.

The paper displays the trend of rainfall events in India in a panel of graphs. As the first picture in the panel shows, it is over central India that there is much rainfall, and hence agriculture that depends on rainfall. The next picture shows that it is in this belt that we have had most of the rainfall events. The two graphs in the middle show that these extreme events have been getting more frequent, in fact, a threefold increase, since the year 1950.

And yet, the next graph shows, the average rainfall, since 1950, in this region where 60 per cent of agriculture depends on rain, shows a decline of 10 to 20 per cent. The fall in average rainfall, the paper says, has been attributed to factors that include warming of the Indian Ocean, El Nino events, air pollution and changes in land use.

A suggestion that the extreme rainfall events during the period are linked to global warming is still not established. Some studies, however, suggest that high moisture content resulting from warming of the ocean is responsible and there is an understanding that implicates the low-pressure zones that form in the Bay of Bengal.

The evidence, however, as the last figure in the panel shows, is that the

low-pressure events have been fewer during the period and there has been less humidity. This raises critical questions, the paper says, "How is the increase in the frequency of extreme events sustained despite a weakened monsoon circulation and a decrease in the number of depressions over central India? Is the moisture content increasing despite a declining monsoon, and if so, what ensures the availability of moisture to foster these extreme events? Is it that the depressions are bringing in more moisture even though their frequency has declined?"

The study has revealed some features that point to answers to these questions. For one, it is found that it is not local conditions, like temperature, that are linked to extreme events. In fact, the paper says, there is a "negative correlation" between the number of extreme rainfall events and the surface temperatures over central India. On the other hand, it is found that there is a connection between the trend of such events and the temperature in other areas, particularly over the Indian Ocean.

It has been suggested that rise in the temperature over the Indian Ocean may lead to rise in water vapour in the atmosphere and hence more moisture over central India. The humidity levels, however, are not statistically linked with extreme rainfall events. And it is seen that the warming and increased moisture over the ocean has not led to more rainfall over central India. The dynamics involved are obviously complex, the paper says.

To track down where the moisture for extreme rainfall events was coming from, the authors of the paper turned their attention towards what they call "widespread extreme rainfall events", or when extreme events occur over a sufficiently large area and can cause largescale floods. As the study also called for high resolution data, the study made use of the satellite data available after 1982. And the study consisted of examining the daily maps of moisture levels and winds during the days preceding extreme events.

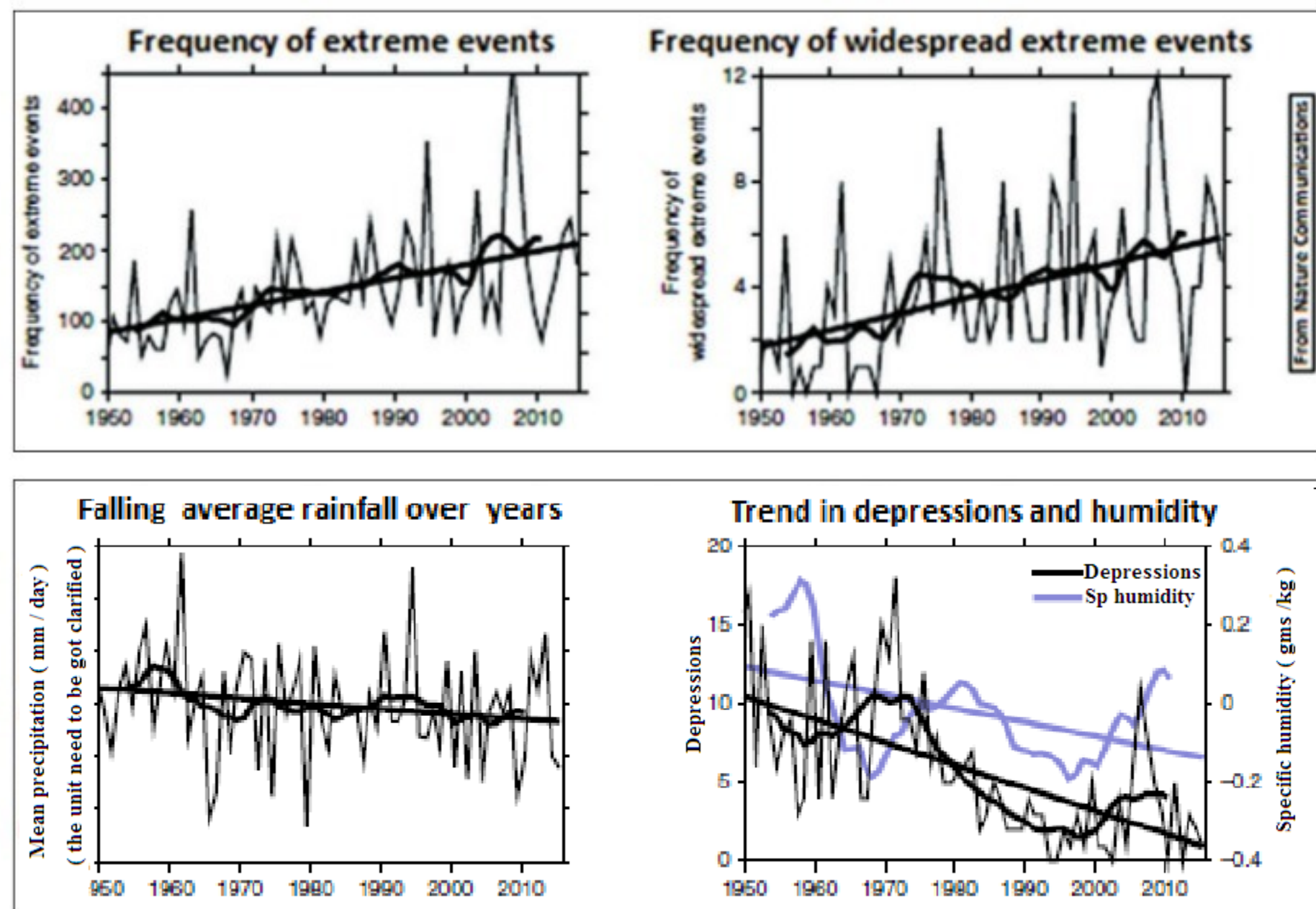
The results were clear evidence of a build-up of humidity over the northern Arabian Sea and then being blown by winds from the west towards central India. The unusual humidity over the Arabian Sea rises till six days before an extreme event and is then blown eastward, leading to heavy rainfall. Analysis of where the moisture that ends up as rain in central India comes from leads to the Arabian Sea being the largest source, followed by local evaporation, while the Bay of Bengal and the Indian Ocean bring up

the rear.

The extreme events over central India are hence seen to be preceded by rising sea surface temperatures in the Arabian Sea, about two to three weeks before the events. While this leads to rising air columns and higher humidity, there is also warming of the land mass in Pakistan and north-western India. The result is a south-to-north pressure gradient, and thanks to the west-to-east rotation of the earth, there arise winds that blow from the west to the east.

The timing of the rise of sea surface temperature is seen to correspond to the westerly wind and rain events that occur 16 to 19 days later over central India. This trend of rising Arabian Sea temperatures preceding rain events is borne out historical data, for instance, the central Indian floods in 1989 and 2000, Mumbai floods in 2005, and South Asian floods in 2007.

There are other studies of the Mumbai floods of 2005 that linked the intense rainfall with an active moisture flow from the Arabian Sea, consistent with the present study. The paper concludes with the observation that anomalies in the surface temper-



ature of the Arabian Sea are likely to increase, and hence the extreme rainfall events over central India.

The correlation of these events, which occur uniformly over a wide

area, with rise in sea temperature, however, makes it possible to make forecasts with few weeks lead time. The paper notes that the cost of collecting data to implement early warn-

ing is minuscule as compared to the losses that arise because of the floods.

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PLUS POINTS

Bed bug dispersal



The study led by Dr William Hentley from the University of Sheffield's Department of Animal and Plant Sciences, suggests that leaving worn clothes exposed in sleeping areas when travelling may facilitate the dispersal of bed bugs. One possible mechanism facilitating the spread of bed bugs is that the insects find their way into clothing and luggage. Bed bugs are attracted to dirty laundry according to new research published by the University of Sheffield scientists.

Published in the journal *Scientific Reports*, the University of Sheffield research conducted experiments in two identical, temperature-controlled rooms in which four tote bags of clothes were placed — two containing soiled clothes, two with clean clothes in the presence of bed bugs. In each run of the experiment, one room received an increase in concentration of CO₂ to simulate human breathing. The Sheffield scientists found that in the absence of a human host, bed bugs were twice as likely to aggregate on bags containing soiled clothes compared to bags containing clean clothes.

The study also found that in the room with increased concentrations of CO₂, bed bugs were more likely to leave their refuge and initiate host-seeking behaviour. Results from the research suggest that residual human odour on soiled clothes acts as an elicitor of host-seeking behaviour in bed bugs. Consequently, dirty laundry left in an open suitcase, or left on the floor of an infested room may attract bed bugs. Dr William Hentley from the University of Sheffield said, "Bed bugs are a huge problem for hotel and homeowners, particularly in some of the world's biggest and busiest cities. Once a room is infested with bed bugs they can be difficult to get rid of, which can result in people having to dispose of clothes and furniture that can be really costly. Our study suggests that keeping dirty laundry in a sealed bag, particularly when staying in a hotel, could reduce the chances of people taking bed bugs home with them, which may reduce the spread of infestations."

Chemical surgery



Scientists have carried out chemical surgery on human embryos to successfully remove a disease for the first time. Researchers at Sun Yat-sen University in China used a technique called base editing to re-programme a fault in a single base in our genetic code. The experiments were carried out in laboratory-made embryos to remove the disease beta-thalassemia, an inherited blood disorder which can cause weakness, fatigue and lead to abnormal blood clots.

In the study, published in the journal *Springer*, the authors wrote, "Beta-Thalassemia is a global health issue, caused by mutations in the HBB gene. Among these mutations, HBB ?28 (A>G) mutations is one of the three most common mutations in China and Southeast Asia patients. Correcting this mutation in human embryos may prevent the disease being passed onto future generations and cure anaemia."

The team edited one of the "fundamental building blocks of DNA" the four bases adenine, cytosine, guanine and thymine (A, C, G and T), the BBC reported. Combinations of these four bases essentially instruct how the human body works. The blood disorder beta-thalassemia is caused by a change to a single base in the genetic code.

Using base editing, the researchers changed a G to an A to remove the blood disorder. Base editing, pioneered by Harvard University Professor David Liu, is a new genome editing technology that allows the irreversible modification of genes within organisms. He described the process as chemical surgery.

Experimenting with a difference

Amanda Feilding has spent decades collaborating with scientists around the world to better understand how psychedelic drugs like LSD, ayahuasca, and magic mushrooms affect the brain



ERIN BRODWIN

According to Amanda Feilding, one tenth of what's considered a full dose of LSD is enough to make her feel "sparkly." As the founder and director of the UK-based non-profit Beckley Foundation, Feilding has spent decades collaborating with scientists around the world to better understand how psychedelic drugs like LSD, ayahuasca, and magic mushrooms affect the brain.

Feilding told *Business Insider* that she experimented with microdosing, or taking tiny doses of psychedelics, in the 1960s as an attempt to increase her creativity and productivity what she refers to as "sparkle." Nearly 60 years later, the practice has emerged as Silicon Valley's favourite illegal drug habit, with engineers, programmers, writers, and artists sharing their stories of microdosing.

Many people say the practice improves their concentration or creativity; others, like writer Ayelet Waldman, who shared her story with the *New York Times*, have turned to the regimen as a way to treat symptoms of mental illnesses like depression and anxiety. But no existing study has looked into the science behind microdosing — a gap Feilding and a team of scientists and passionate fundraisers are hoping to fill.

Feilding's new study will begin later this year, looking at 20 participants over the course of four "study days." Each day, the volunteers in the study will get one of four possible doses of LSD — 0, 10, 20, or 50 micrograms and then do a series of tasks, answer questionnaires, and have their brains scanned. Each test is designed

to see if and how the drugs affect people's creative and cognitive abilities. The researchers also hope to learn whether micro-dosing affects communication within and between brain networks the same way a full dose of psychedelics has been found to do.

"We want to look to see if we see those changes in cerebral circulation and connectivity and hopefully things like the 'aha!' moment that comes with creativity as well," said Feilding, adding that they hope to see the results as early as the end of the year.

For the study, Feilding will be collaborating with London Imperial College psychopharmacologist David Nutt. New York University researchers Stephen Ross and Michael Bogen-shutz are also involved in a series of related trials that are currently still in preliminary phases. "It's a study I've wanted to do for 30 years. I'm very interested in that level of cognitive enhancement which isn't a full-blown psychedelic state but is a lift in productivity and cognition and amusement or thinking further than one usually does," said Feilding.

The existing research on psychedelics has been promising so far, but is still in its early stages. Most studies focus on "trip treatment" essentially giving someone a "full" dose of psychedelics so that they trip or hallucinate. Patients in these studies have said the experience was overwhelmingly positive; many describe the trip as one of the most important experiences of their lives.

Psychedelic micro-dosing differs from a "trip treatment" in that it involves taking tiny amounts of a psychedelic drug several times over a few days, rather than a single, full dose.

Whereas participants were injected with 75 micrograms of LSD in one study, for example, micro-dosers report taking about 10 micrograms, or roughly one-fifth to one-tenth of a standard recreational dose, once every four days. These levels are intended to be "sub-perceptual," NYU psychiatrist Stephen Ross tells *Business Insider*. In other words, they're too small to cause a trip, but large enough to potential affect thinking and creativity.

Another issue with today's micro-dosing trend is that it can be difficult to verify whether the LSD is actually causing the effects that people report and, more importantly, that the drugs people are taking are safe. That's one of the problems that the current and future studies aim to address.

Scientists can't say for sure what goes on in the brain after a full dose of psychedelics is taken, or precisely why it appears to produce such profound, life-altering experiences. What they do know, David Nutt told *Business Insider* in January, is that in a psychedelic trip, the normal hubs which control and regulate brain function become disrupted. There is much greater connectivity parts of the brain that rarely talk to each other.

During a psychedelic trip, certain brain circuits are subdued while others get ramped up. The circuit that connects the parahippocampus and the retrosplenial cortex a network thought to play a role in our sense of self, or ego is one that that appears to be subdued during a trip. And deflating the ego appears to make people feel more connected to the people and environment around them.

"The normal sense of self is broken down and replaced by a sense of reconnection with themselves, others, and the natural world," Robin Carhart-Harris, who conducted the first study that took images of a healthy brain on a trip-inducing dose of LSD, said at a conference in 2013.

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