DELUGE OF THE CENTURY

Kerala's worst flood since 1924 reinforces how local environmental degradation and lack of disaster preparedness can make extreme weather events deadly

SHREESHAN VENKATESH WITH
REJIMON KUTTAPPAN IN KERALA

August 19, 2018
People wait for aid next to a makeshift raft at a flooded area in Kerala

REUTERS

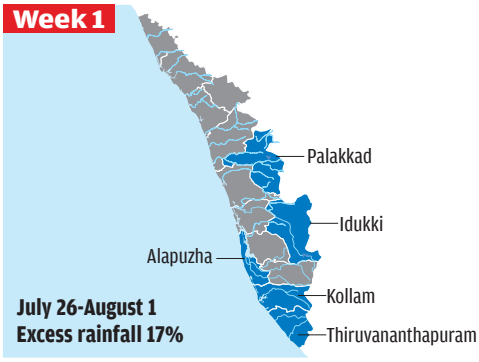
WE CAN'T understand which one is river and which one is road." That is how Rajesh S, a resident of Chengannur town in Kerala, described the ground zero situation to *Down To Earth* (DTE) speaking over a mobile phone. River Pamba swelled bringing Chengannur under water. "But we all expected this would happen," he says. The day the state government decided to open all the dams, Rajesh told DTE, the devastating flood was just a matter of time. As the outside world tracked news of heavy rains for more than a week after August 8, the response was just a habitual disclaimer. For a state living with two monsoons and fighting drought for the last three years with a monsoon deficit ranging up to 34 per cent, it was a respite. Day after day, over 11 days, floods gripped all the state's 14 districts with an unheard of ferocity. Amateur mobile videos of the destruction started streaming out: hills crumbling down as debris, people being swept away by gushing streams, dams brimming with water and most of the towns and villages filled with displaced people. This was Kerala's worst flood in almost 100 years.

On August 19, for the first time in the preceding 11 days, satellite images of Kerala captured fractures in the cloud cover. The state government lifted the red alert consequently. The fragmented clouds over the state unearthed the real devastation. Everybody had one question: was it normal?

"It is abnormal but not unusual," says D S Pai, the head of climate services division of the India Meteorological Department (IMD). Official response is always presented using the tact of terminology. Over 11 straight days of tempestuous rainfall, nearly 25 trillion litres of water fell on Kerala—an area of

August 19, 2018
Volunteers work at an aid distribution centre inside a stadium in Kochi

REUTERS



"It is now found that the increase in heavy rains is relatively more during the break phases than the active phases. This means that there is a flattening of the monsoon intraseasonal oscillation in the recent years so there are few well-defined breaks"

ROXY MATHEW KOLL, scientist, IITM

38,800 square kilometres cramped with mountain ranges; third-highest population density in the country; and, 44 rivers with 61 dams—with apocalyptic fury.

A ravaged landscape

The state doesn't have the experience of coping with this scale of damage to life and property—it claims that only 14.52 per cent of its area is flood prone. At the time of writing, the government confirmed 387 deaths. The state government has estimated the preliminary loss at ₹20,000 crore, which is around 15 per cent of the state's GDP estimate for 2018-19. According to risk management agency, Care Ratings, floods have affected more than four million people, a significant percentage of them labourers. In August alone, people would lose wages worth ₹4,000 crore. More than one million people are in relief camps that would take around ₹300 crore a month to maintain. More than 12,000 kilometres of roads have been damaged hindering speedy relief and rebuilding operation. In totality, the state's growth rate would be down by one per cent.

The current flood came after a strange phase of the monsoon that defied normal rainfall pattern. On an average, Kerala receives close to 3,000 mm of rains annually. Of this, the monsoon is responsible for slightly over 2,000 mm. But this year it surpassed this despite the fact that around a third of the monsoon season is yet to come—by August 19 the state had received close to 2,350 mm of rains. According to IMD, Kerala received 2,346.6 mm of rainfall against a normal of 1,649.5 mm since the beginning of June—an excess of 42 per cent.

Typically, Kerala receives strong monsoon showers in June and July as the southwest monsoon gains strength, after which there is a lull in the latter two months of the monsoon. While the first two months saw slightly above normal rains this year, the normalcy did not extend into August. Within the first three weeks of the month, the state received close to 500 mm of rain over and above the normal rainfall of about 290 mm. Of the 760 mm rainfall received by the state since the beginning of the month, close to 75 per cent was received in the eight days between August 9 and 17, representing a departure from normal by around 300 per cent for the time period.

The distribution of the Indian monsoon is directed by the location of the monsoon trough—a belt of low pressure caused by solar heating. The axis of this trough oscillates between the Himalayan foothills and central India. In its normal position, the trough extends from northwest India to the east coast, close to Odisha and West Bengal. At this position, central India and the west coast get good rains. When the trough moves north the monsoon is said to be in "break" phase and most of the subcontinent barring the Himalayan states receive little or no rain. The "active" phase of the monsoon is when the trough moves south of its normal position causing heavy and intense showers in the southern peninsula. Between August 8 and August 16, Kerala received two spells of

widespread intense rains. The first spell of heavy rains prior to August 10 was heralded by just such a system and was anticipated by monsoon trackers.

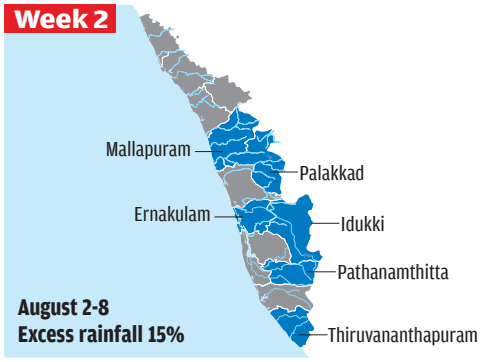
Atypical cycle

What came as a surprise though was the second spell of rainfall after August 14. The western end of the trough at the time was not stable and oscillated north-south of its normal position. The position of the monsoon trough helped the formation of an offshore trough that is responsible for most monsoon rains in the west coast. However, the instability of the monsoon trough resulted in only a feeble offshore trough. This atypical second spell of rains from August 13 onwards overwhelmed the state by pounding the region with the highest concentration of reservoirs in the state.

Between August 8 and August 15, each of the 14 districts of the state recorded much more than normal rainfall. The worst hit were the districts of Idukki (679 mm), Wayanad (536.8 mm), Mallapuram (447.7mm), Kozhikode (375.4 mm) and Palakkad (350 mm), each of which received rains that were several times more than the normal. The situation further worsened in Palakkad and Kozhikode as heavy rains were recorded until August 18.

"This year the association of monsoon rains with trough position is not as strong as it is in most years. For one, the active-break cycle is not as stark as it is usually and we are seeing more and more extreme events even during the supposed break phase. While this is not unheard of, it is not the typical condition during monsoons," says Pai. "The feeble offshore trough, off the western coast, is the reason for the high cumulative quantity of rain received by Kerala. While the offshore trough stretching from northern Kerala towards the rest of the west coast is not unusual, the recent rains in Kerala indicate that the offshore trough did not move. The strong monsoon winds converged over a single region and that is why the cumulative rainfall in Kerala has been so high," says Akshay Deoras, an independent forecaster.

While the offshore trough is the reason for the rainfall, it is not the only determining factor in the distribution of rains. How monsoon winds move and bring rainfall is also heavily dependent on the formation of low pressure systems and depressions over the Bay of Bengal (BoB) and their movement over the mainland. Typically, low pressure systems develop over northern BoB, near the West Bengal coast, and move west-northwestwards. However, during the spate of rainfall in Kerala in mid-August, the low pressure system associated with the heavy rainfall formed closer to the Odisha coast. Subsequently, it moved west-southwestwards towards Maharashtra rather than the normal route that results in rains in central India and the Indo-Gangetic plains. "Generally the depressions associated with such floods occur over the north of BoB. But this time, it occurred over the south of



"The rainfall over Kerala is not unusual but rather abnormal. Since June, we have received good rains all over the west coast including Kerala. Dams were full by the end of July but dam water wasn't released at the time, which caused an urgent release in August"

D S PAI, senior scientist, IMD

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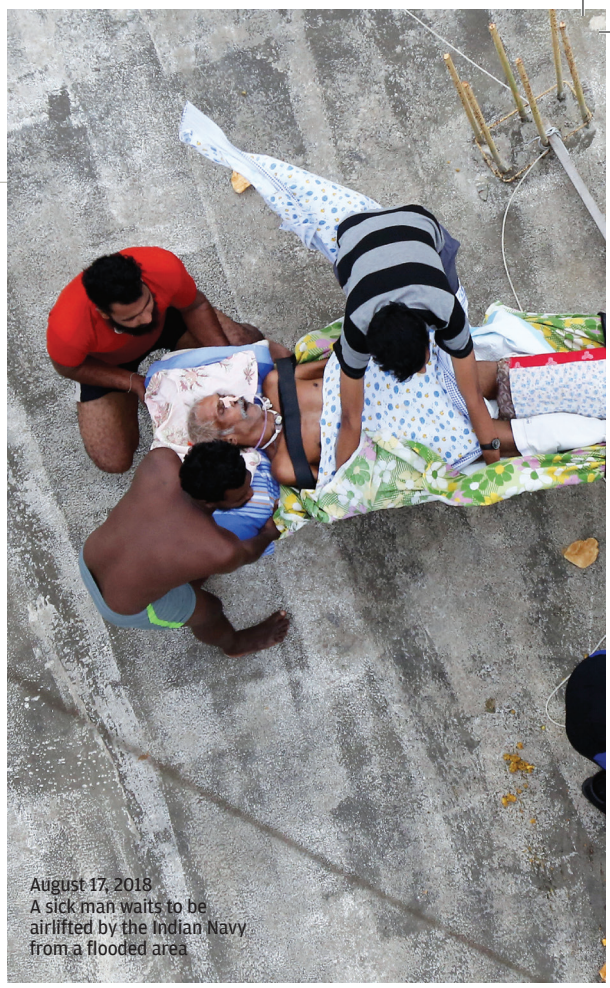
BoB. Initial analysis shows that this might have anchored the monsoon westerlies over Kerala. Normally with the depression over the north BoB, the westerlies would have been towards the north of Western Ghats, with places like Mumbai receiving heavy rains," says Roxy Mathew Koll, a scientist with the Indian Institute of Tropical Meteorology, Pune.

The numbers of low pressure systems that have developed into depressions that influence the distribution of monsoon rains are below average this season. The climatologically average indicates the development of six well-marked depressions during the four monsoon months—one each in June and September and two in the months of July and August.

However this year, the first depression was formed only in the end of July. With only a little more than a month left, only three depressions have formed so far in BoB and moved into the Indian mainland. The reduced number of depressions has suppressed distribution of rainfall in the subcontinent and has contributed to the concentration of rainfall over four prolonged spells primarily in the west coast since the onset of the monsoon.

Meanwhile, rainfall in the rest of the country so far does not inspire confidence with only a fourth of the conventional monsoon remaining. Despite floods in nine states, 41 per cent of India's districts are still facing a rainfall deficit (see 'Excess rains plague India', *p*41).

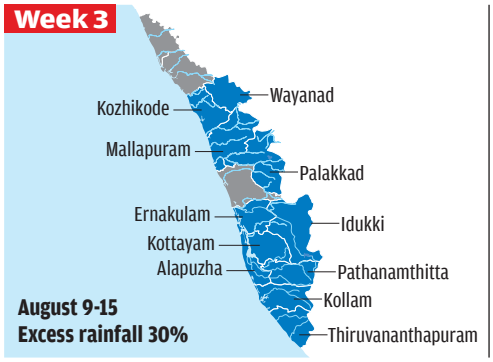


August 17, 2018
A sick man waits to be airlifted by the Indian Navy from a flooded area

The trigger

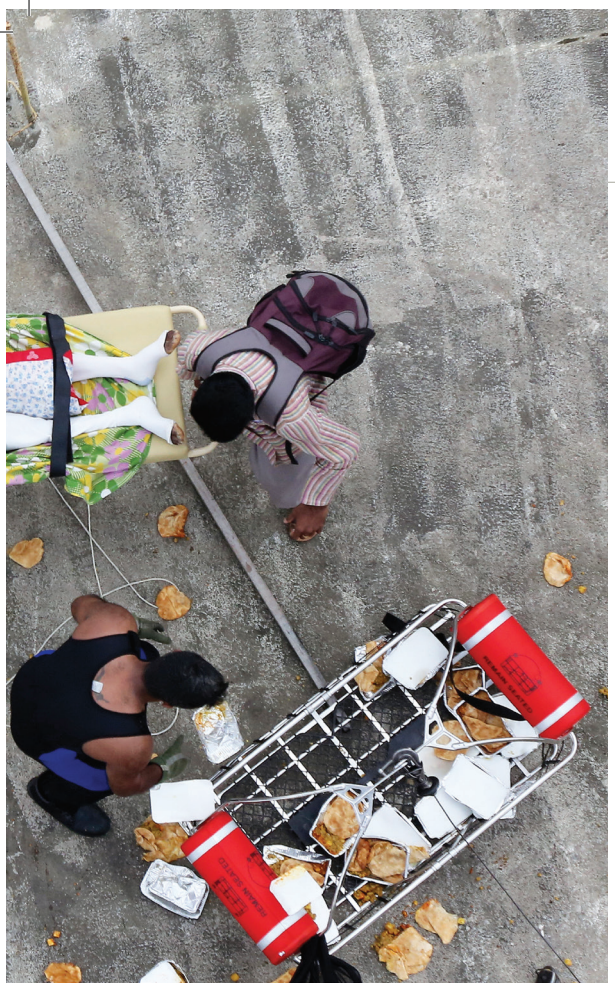
What made this "abnormal" climatic episode deadly were the state's faulty disaster responses—both short- and long-term. Shockingly, the Central Water Commission (cwc), India's only flood forecasting agency, doesn't have any flood forecasting system in Kerala. This deprives the people of the state any reliable way for flood preparedness.

Kerala is ecologically sensitive owing to the geography and topography of the region. Practically, the entire state is drainage medium for run-off from the Western Ghats



"Holding or releasing water from dams, and understanding what level of flooding it may cause, is complex. Holistic water management that includes appropriate release of water from dams, impact forecasts and warning dissemination could save lives"

ANSHU SHARMA, disaster risk reduction expert



REUTERS

towards the Arabian Sea. As a result, the state has a dense network of rivers linking the hills to the sea. While rain is abundant across the state, statistics over recent monsoons reveal that it is, in fact, the coastal regions, especially in northern Kerala, rather than the Western Ghats that receive the bulk of the rainfall during the monsoons. Because of this, Kerala's rivers are spared the flooding risks associated with rivers swollen with heavy volumes of run-off. This year though has been extremely wet for the ghats of Kerala and this is precisely what submerged the state. Between August 1 and August 15, Idukki—which is nestled deep in the Western Ghats and holds 17 reservoirs (the most for any district in the state)—received more than 800 mm of rain. Similarly, in Palakkad which has the second highest concentration of reservoirs, the amount of rainfall recorded between August 1 and August 18 was close to 700 mm. In both these places, the rainfall recorded exceeded 200 per cent above normal for the region and floodgates of at least 29 dams in the districts had to be opened adding to the flood fury and landslides in downstream areas. "The infrastructure definitely added to the magnitude of the

Samaritans all

Even before government agencies could reach flood victims, survivors started conducting relief operations in Kerala

THE FLOODS in Kerala are not just a story of poor planning or nature's fury, it is also about Kerala's unique resilience that shone through during trying time. The defining aspects of the rescue and relief operations were undoubtedly the calm coordination between the multitude of civil actors from government officials to fisherfolk, white collar professionals to school children, all of whom turned up when they were needed the most. Schools, churches, temples, universities, commercial complexes were all converted to temporary relief camps in almost no time.

Much before the Navy and the Coast Guard came to rescue people from Kerala's sinking villages and towns, the locals, sensing the ferociousness of the floodwaters, banded together to save their own. People went from house-to-house, knocking on doors in the dead of night to tell strangers, friends and family that it was not safe to stay at home.

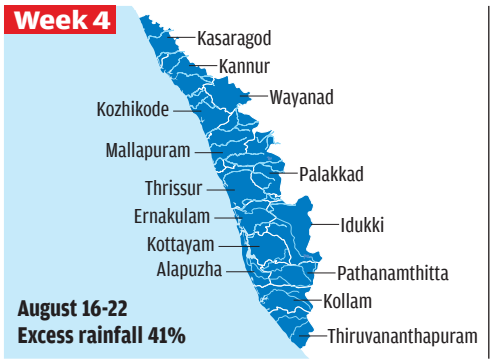
Those in low-lying areas were swift in assessing the danger, grabbing clothes and a few essential items and running out of their homes. Others, who had the luxury of upper floors, sat nervously for hours before listening to their villagers' appeals. They had the more ominous stories to tell, escaping in a wobbling fishing boat or canoe as it danced left and right in the intense currents of the river. Together, the villagers who probably didn't even know each other's names, showed extraordinary courage in the face of adversity.

The first reaction within the state was a collation of information on people who were missing or stranded that was circulated swiftly through social media networks. Along with names, location-based requirements of essential items were quickly distributed on multiple platforms with social media proving to be the cornerstone of probably the world's largest such citizen-led rescue and relief operation.

High education levels and comfort with technology helped in such efforts mushrooming all over the state. Before long, the state government began centralising all efforts through a single website. Vitally, the website enabled effective coordination and communication between the public, rescue volunteers and government authorities at different levels.

While Kerala's netizens ensured that social media's exponential reach was put to good use, coastal fisherfolk of the state emerged as the heroes on the ground. Venturing inlands with their boats, the fisherfolk were an invaluable link in Kerala's rescue efforts as they could reach hopelessly cut off places to locate and save tens of thousands of people across the state. The state offered fisherfolk involved in rescue efforts ₹3,000 for each day of their help only to be refused by them.

Meanwhile, volunteers poured in from all over the state and the country to help out with distribution of aid, provide medical assistance and help in rescue efforts. Yet by all accounts, relief camps were an epitome of composed coordination. Devastating floods can seldom be recalled among the finest hours of a society, yet this is exactly what the Kerala floods were described as by none other than UN Environment's Disaster Risk Reduction Chief Muralee Thummarukudy. And it would be difficult not to agree with him. The strength shown by Kerala's communities in tiding over the deluge is the sole bright light in an otherwise grave time.



"Opening dams earlier might have bought some time. Dam storage has reduced because of siltation. As a result, water is stored at dangerous levels. Further, development in the last 20 years has changed land-use and social relations and worsened the inundation"

ANIL GUPTA, environment and climatic disaster management division, NIDM

flood," says Vishwas Kale, a former head of geography department, University of Pune and a hydrology expert, adding that, "the situation cannot be compared to the 1924 floods because the level of infrastructure then wasn't the same as today".

It is clear by this time that while the state was under a heavy spell of rain, the opening of all its dam gates aggravated an already out of control situation. At least 39 dams were full in the range of 85-100 per cent with water by July end. As the August deluge was not expected, the dams were allowed to fill water till the highest level. The rains in August raised safety issues.

So, while the state was already flooded, 35 dams were discharging water, with all their gates opened at the last minute. "The flood damages could have been reduced by 20-40 per cent had the dams and reservoirs released the water slowly in the two week period when the rains had subsided. The state did not have an advanced warning system in place and released water from the dams only once the danger levels (levels at which the dams structures can be damaged) were reached," says Ashok Keshari of Indian Institute of Technology, New Delhi.

As per the Crisis Management Plan for Dam Failures, prepared by the National Committee on Dam Safety, states are supposed to come out with their Emergency Action Plans (EAPS) for every large dam. It's also shocking that CWC had prepared the guidelines for "Development and Implementation of EAPS for Dams" in May 2006 and had circulated it to state governments for action. According to a recent Comptroller and Auditor General report, out of 61 dams in Kerala, none had EAPS or operation and maintenance manuals.

But before the dam water made the state into a sea, the damage to local ecology done over the years had already caused much devastation. Scanning situation reports of the state's disaster management control room, one pattern clearly emerges: damage to life and property was more in certain areas. These are areas earmarked as ecologically sensitive and have always been cautioned on landslides triggered by rains. In the second and third week of August, mudslides and landslides were reported in 211 places across the state, and this is attributed to increasing stone quarrying activity and large-scale deforestation.

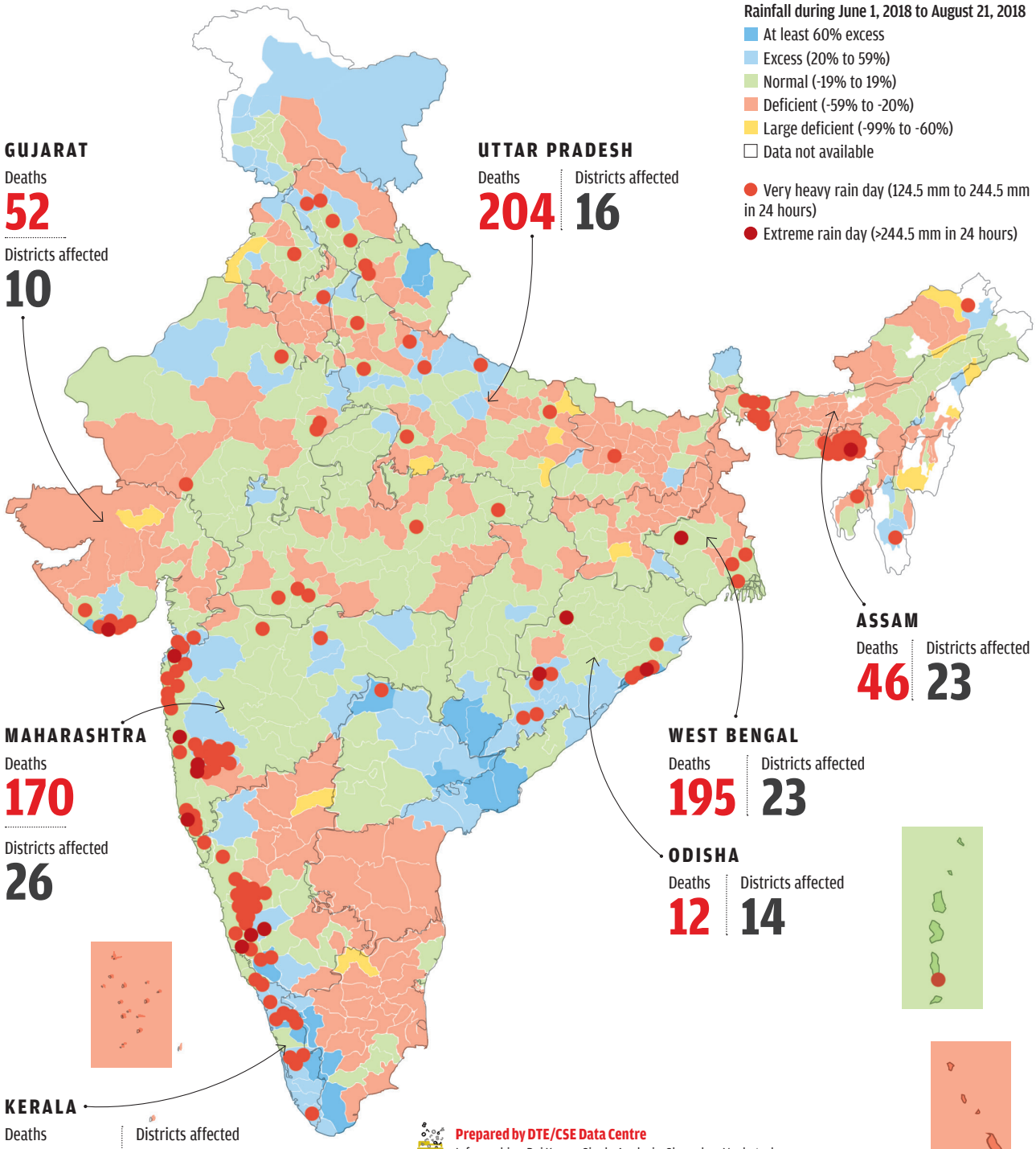
Idukki and Wayanad are considered among the most heavily-forested districts in the state. However, both have seen a decline in their forest cover between 2011 and 2017. The total forest cover in Idukki came down from 3,930 sq km to 3,139 sq km, a decrease of 20.13 per cent. In Wayanad, forests shrunk from 1,775 sq km to 1,580 sq km, a decrease of 11 per cent. This could be the reason these two districts reported the maximum damages due to flash floods and landslides.

By August 22, the state government was still assessing the impacts of the floods. But the meteorological mayhem indicates a new normal fuelled by climate change. This year there has not been a respite from extreme weather events. And it is one of many such episodes playing out across the world now.

MONSOON 2018

Excess rains plague India

Rainfall during monsoon is becoming more extreme and frequent throughout the country. This is causing floods, claiming lives and damaging property



Prepared by DTE/CSE Data Centre
Infographics: Raj Kumar Singh; Analysis: Shreeshan Venkatesh
Source: Agricultural Meteorology Division, IMD; Hydrometeorology Division, IMD; and NDMA Flood Situation Reports
For more such infographics visit: *www.downtoearth.org.in/infographics*

Wake up before it is too late

From the US and Europe to Japan and Africa, extreme climate events have become an everyday reality. Managing them is one of the biggest challenges of our times

EVEN AS flood waters recede in Kerala and the enormity of the task of rebuilding becomes evident, a similar exercise is unfolding nearly 7,000 km away in western Japan. Between June 28 and July 8, a stationary rainy front, in addition to damp air remaining from the recently-dissipated Typhoon Prapiroon, caused extremely heavy rainfall in western Japan, according to the Japan Meteorological Agency. Total precipitation at many places reached up to four times the mean monthly precipitation for July.

The floods claimed over 200 lives and eight million people were asked to evacuate. However, the process of rebuilding was hampered by another climate anomaly—an intense heat wave that has afflicted the region. Southeast Asia too faced the brunt of flooding with Myanmar, Cambodia, Laos and Thailand recording intense rains and flooding over the past two months.

Weather-wise, the situation has been just as alarming across the globe. 2018 is already one of the hottest years ever recorded. And for this there is no dearth of evidence. As a scorching summer in Asia is followed by intense rainfall and heavy flooding, the other side of the Northern Hemisphere, including North America, Europe and northern Africa, have been in the grip of intense and prolonged heat waves. Temperatures have been soaring above the normal range for nearly six months now, breaking records in several places, including some in South America. Before the mercury rose, the Northern Hemisphere winter too was erratic bringing rains to Europe and blizzards to North America. Expectedly, the wildfire season has been quite active in both continents. The Australian summer early this year too saw unprecedented temperatures and wildfires. However, what has taken observers by surprise is that the upper limit of forest fires and wildfires has now breached the Arctic Circle with around 50 wildfires being reported from the Scandinavian region during summer. Sea ice coverage around both poles have shrunk considerably as temperatures several degrees above average have been recorded over the year.

Long-term predictions, which give the illusion of climate impact being several decades away and ameliorate the urgency of climate action, are already reflecting in extreme events across the world

The overarching source linking these separate instances of extreme and unpredictable weather anomalies has been identified high up in the atmosphere. The jet stream—a ribbon of high velocity winds that circulate around the Earth several kilometres above the surface—has been deviating from its beaten path. The jet stream in recent times has been observed to be undulating in sharp loops towards the poles and the equator, rather than its normal path which is nowhere nearly as convoluted. The reason for the change in the jet stream paths is ostensibly the increase in global temperatures and the reduction in the gradient between polar and equatorial temperatures which influence the direction of the jet streams. The dust storms and intense convective activity across the Indo-Gangetic plains in April and May 2018 is, in part, attributed to this recent contortion in the jet stream path.

TRAINING ON URBAN WETLANDS MANAGEMENT

Towards Water and Environment Sustainability

Date: 25 September to 28 September, 2018

Venue: Anil Agarwal Environment Training Institute (AAETI), Nimli, Rajasthan

ABOUT THE TRAINING

In the wake of frequent recent floods in several urban localities in India as well as international recognition of urban wetlands significant role in water and sanitation management, IUCN has dedicated this year to Wetlands for Sustainable Urban Future, the School of Water and Waste, AAETI, Centre for Science and Environment (CSE) is organizing a four days training on Urban Wetlands Management. The participants will have the opportunity to interact with resource persons from both international and national institutions in this field such as IUCN, NEERI, Biome Environmental Solutions (BES), Centre for Inland Waters in South Asia (CIWSA), Wetlands International South Asia and Indian National Trust for Art and Cultural Heritage (INTACH).

AIM

The aim of the training is to develop capacity of various stakeholders on conservation, restoration, planning and management of wetlands for water and environmental sustainability in urban areas.

OBJECTIVES

- Improved knowledge on urban wetlands management - the concepts, tools and techniques.
- Develop skills in mapping of wetlands
- Understanding of wetlands as a source of urban water supply, groundwater recharge and wastewater treatment
- Prepare Urban Wetland /Lake /Flood plain Management Plan.

WHO CAN APPLY AND HOW TO APPLY?

Government and non-government officials working on wetlands including lake development and management. Independent consultants, representatives from NGOs and researchers working in relevant area.

For filling the application form for registration and scholarship, visit : https://www.cseindia.org/training-on-urban-wetlands-management-8852

Full fellowship includes travel, boarding & lodging costs and training kit & fees costs.

Part fellowship includes boarding & lodging costs and training kit & fees costs.

Only the short-listed candidates will be informed and the selection decision of School Committee would be final.

COURSE COORDINATOR

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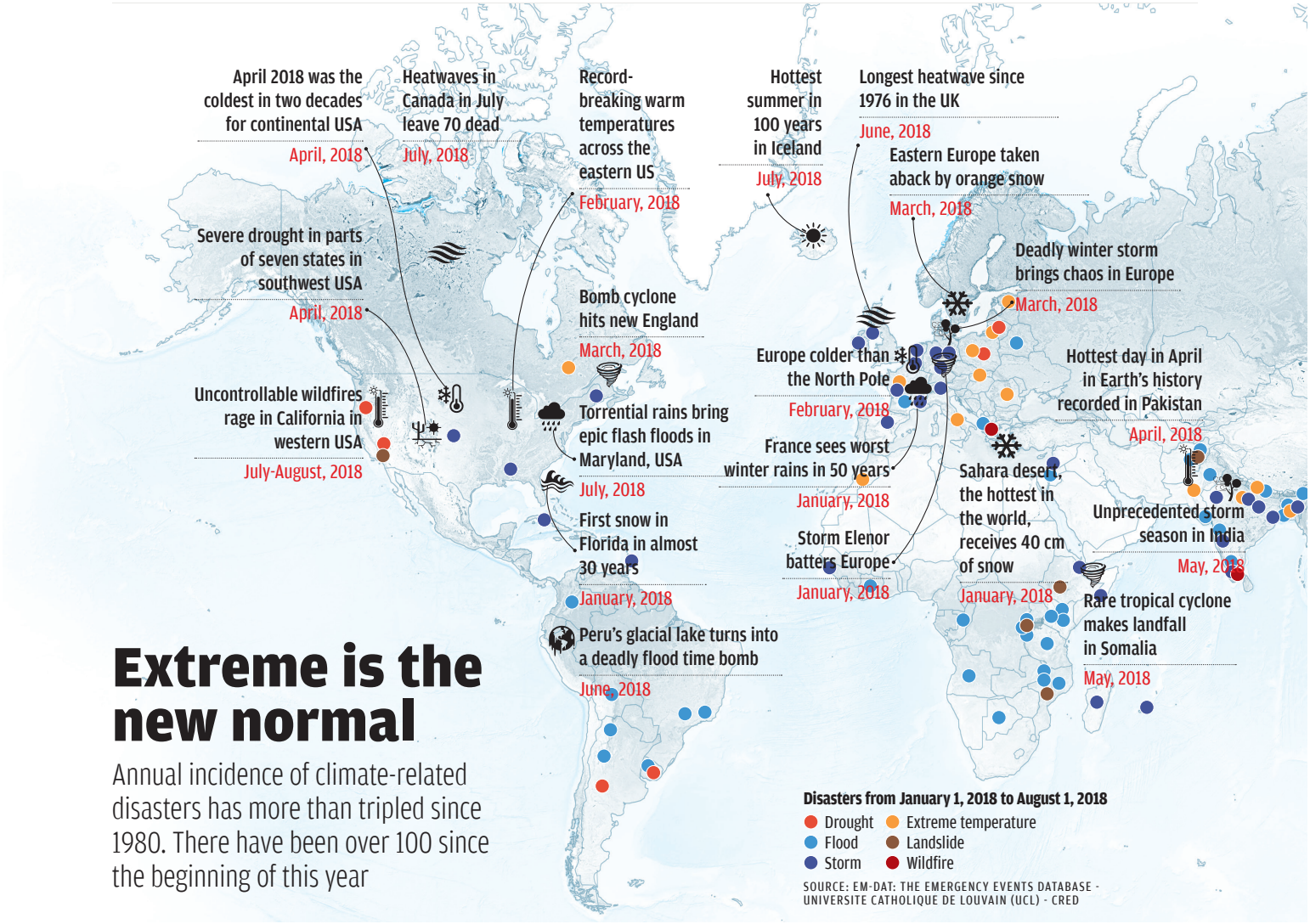


Extreme is the new normal

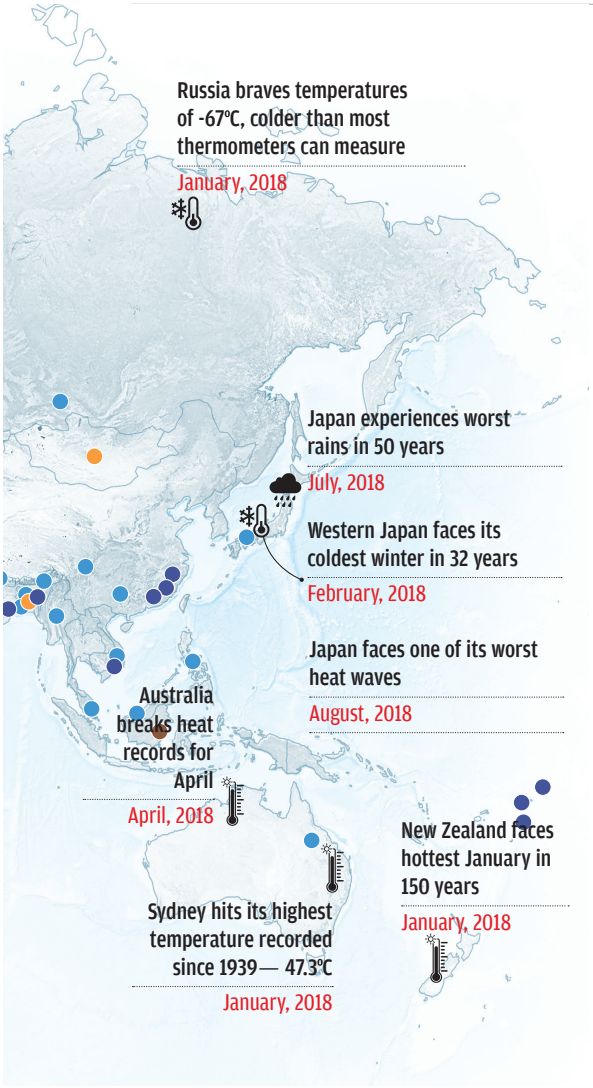
Annual incidence of climate-related disasters has more than tripled since 1980. There have been over 100 since the beginning of this year

Already in the midst

The striking reality of climate change is that its impacts are already visible in every corner of the world. This is not some far-fetched prediction but is already happening all around us. The distribution of extreme weather and climatological events since the beginning of the year is evidence of exactly this—not a single region of the world can claim to be insulated from the climate change disturbances. According to the EM-DAT disaster database based in Belgium, there have been over 100 climate-related disasters until the beginning of August this year in which close to 3,000 people died (see 'Extreme is the new normal').

A look at the trend of reported natural disasters over the past four decades paints an even starker picture. The incidence of climate-related disasters since 1980 have more than tripled to over 300 events every year. Both meteorological and hydrological disasters such as storms, extreme precipitation and floods have increased by as much as four times in the 40-year period.

As climate change impacts increase in frequency and intensity, the most worrying thing is that Earth is only about 1° C warmer than it was in the 1950s, and that it is firmly on a trajectory that will be between 3-4° C warmer by 2100. A recent paper published in the journal *PNAS* in August 2018 looked at historical glacial-interglacial cycles the Earth has undergone, and compared it with a theoretical estimation of future climatological cycles through a systems approach if global warming is not contained. The paper suggests that "the Earth System may be approaching a planetary threshold that could lock in a



continuing rapid pathway toward much hotter conditions—Hothouse Earth. This pathway would be propelled by strong, intrinsic, biogeophysical feedbacks difficult to influence by human actions, a pathway that could not be reversed, steered, or substantially slowed. Where such a threshold might be uncertain, but it could be only decades ahead at a temperature rise of 2.0° C above preindustrial, and thus, it could be within the range of the Paris Accord temperature targets".

The paper's conclusion is undoubtedly scary, but there isn't much evidence to counter the inference that the researchers have reached. The *PNAS* paper is a timely publication; in some ways is an apt curtain raiser for the much-awaited Intergovernmental Panel on Climate Change's (IPCC) 1.5 Degree Special Report. This report may well determine the urgency and efficacy of the post-Paris Agreement climate action.

While the final version of the report will only be published this month, a preliminary draft was leaked earlier this year. Average temperature rise globally has escalated year-on-year, especially since the 1990s and is currently close to 1.2° C above the pre-industrial average. Around the Arctic Circle, the increase is around 4° C above pre-industrial levels. The leaked version of the Special Report unsurprisingly suggests that the Earth is on its way to breach the lower limit for warming of 1.5°C set under the Paris Agreement. The report points out that though limiting warming to 1.5° C is still geophysically possible, but it would require drastic and rapid reductions in greenhouse gas (GHG) emissions by governments which would include a sharp shift from fossil fuels as well as removal of carbon dioxide (CO_2) from the atmosphere.

According to the draft, humanity can emit just 580 billion tonnes of CO_2 equivalent of GHG to get a better than 50 per cent chance of limiting warming to 1.5 °C. At the current rate of emissions, this is roughly 12-16 years from now. In 2016 alone, 53.4 billion tonnes of CO_2 equivalent GHGs were emitted globally. The draft has warned that adhering to the limit would require a shift towards renewable as the dominant source of energy, coupled with efforts to increase forest cover and other carbon sinks to sequester GHGs. According to the authors, any emission pathway with greater-than-50 per cent chance of limiting warming to under 1.5° C until the end of the century would require the world to reach net-zero emissions around mid-century.

While the urgency of the situation is clear—both from the science of climate change as well as from mounting climatic experiences across the world—the emission pathways currently underway will hardly change the trajectory of global warming. One can only hope that the next rounds of climate change negotiations will include the urgency of addressing the dawning realities of the Anthropocene. ■ @down2earthindia