

► the spotlight as a public face of extreme weather. “I felt a mixture of elation but also sadness,” she says. “To have a temperature like that — there are consequences globally if this is to continue.”

National meteorological agencies around the world maintain long-term records of temperature, rainfall and other weather data. The all-important temperature measurement must be taken in shade above a natural surface, such as grass or sand, rather than asphalt. Many official weather stations, including the one in the Cambridge garden, are mounted inside elevated boxes called Stevenson screens. These are painted white to reflect as much of the Sun’s heat as possible, and slashed with louvres for ventilation.

In California’s Death Valley National Park — one of the hottest places on Earth — the Stevenson screen rises above the desert floor behind the park headquarters. Every morning at 8 a.m., a park ranger unlocks a gate, opens the door to the Stevenson screen and reads a mercury thermometer that displays the hottest temperature of the previous 24 hours.

“It’s an exciting thing to go out and check,” says Sarah Carter, a ranger at the park who oversees the temperature measurements.

HOT ON THE TRAIL

Globally, both night-time and daytime temperatures have been rising over the past century, with nights outpacing days². But it’s the jaw-dropping daytime highs that often capture the most attention. Tourists in Death Valley often take selfies in front of an unofficial temperature display at the visitors’ centre — especially when the reading passes 120°F (49°C).

Whenever temperature measurements

approach world-record territory, the World Meteorological Organization (WMO) springs into action. Its world weather and climate extremes team collects and validates extreme observations from around the globe³. The hottest temperature reading it considers official is a searing 56.7°C measurement taken in Death Valley in July 1913.

But there are hints that the record could soon fall. In June, the WMO team confirmed that two readings of 54.0°C — one from Kuwait in July 2016 and one from Pakistan in May 2017 — are the highest temperatures observed anywhere in the past three-quarters of a century.

The reading in Pakistan was taken by a weather observer at Turbat airport in the country’s southwest. It wasn’t obvious at the time that the reading might be more than a national record, says Nadeem Faisal, director of the climate-data centre at the Pakistan Meteorological Department in Karachi. But the following day, a weather observer in Australia pointed out that it could be a record for all of Asia.

The WMO committee that started investigating the potential record was already looking into a 54.0°C reading taken in Mitribah, Kuwait. The thermometers from both sites were shipped to a metrology laboratory in Italy for further study.

After calibrating the thermometers against each other, the WMO team concluded that the Kuwait instrument had measured 53.87°C (with an uncertainty of 0.08 degrees), whereas the one from Pakistan had measured 53.72°C (with an uncertainty of 0.40 degrees). They are now the third and fourth highest temperatures recognized by the WMO and officially the highest ever recorded in Asia, the team reported in June⁴.

And deserts aren’t the only places setting records. Several sites in Antarctica have been battling for the hottest-temperature record on the coldest continent. Last year, the WMO team ruled that a 17.9°C reading taken in March 2015 by a Czech weather station near the Antarctic peninsula was off by nearly one degree, thanks to high solar radiation and low wind speed around the weather sensor. A 17.5°C reading taken the following day at a nearby Argentinian base now holds the record⁵.

It might not stand for long. Global warming has increased the chance that the hottest daily and monthly temperature readings around the globe will rise⁶. Climate scientists have found that the July heatwave that baked much of western Europe, including Martyr’s garden, was up to 3°C warmer than it would have been without human-induced climate change.

And that means there are probably more record-breaking temperatures to come. Randall Cerveny, a meteorologist at Arizona State University in Tempe who oversees the WMO group, says that the team is much busier than he expected when it was set up in 2007.

“I was anticipating we would have one to two investigations every couple of years,” he says. “Now there are a lot of extremes that we have to evaluate.” ■

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MARINE SCIENCE

‘Ecological grief’ grips scientists

Researchers documenting the decline of the Great Barrier Reef say their work takes an emotional toll.

BY GEMMA CONROY

When Australia’s Great Barrier Reef, the world’s largest coral-reef system, was hit by record-breaking marine heatwaves that bleached two-thirds of it in 2016 and 2017, many researchers were left in a state of shock.

Social scientist Michele Barnes witnessed this disaster at first hand. She works at the

Australian Research Council Centre of Excellence for Coral Reef Studies in Townsville, which is adjacent to the reef. Barnes decided to interview scientists and others working on the reef to investigate their responses to this climate-change-driven catastrophe.

Barnes, who is still analysing her results, was surprised that many of the scientists whom she interviewed felt intense grief and sadness about the reef’s deterioration. *Nature* has also spoken

to several coral-reef scientists not involved in Barnes’s study who echo those sentiments.

“I now feel much more hopeless, and there’s a deeper anxiety breaking through,” says John Pandolfi, a marine ecologist at the University of Queensland in Brisbane, Australia.

Pandolfi has been studying ecosystem dynamics in the Great Barrier Reef for more than 30 years. The consecutive bleaching events that began in 2016 triggered mass death of the reef’s coral cover, which caused a drastic shift in its species composition. Pandolfi is now investigating new configurations of species that have arisen because of human impacts.

An emerging body of research shows that many people feel loss due to environmental degradation caused by global warming, a phenomenon called ‘ecological grief’. Although researchers are often on the front lines of ecosystem collapse, few studies have investigated the mental and emotional consequences of such work.

For Pandolfi, the consequences he worries about are those that his children — now 17 and 20 — will face as a result of climate change. “I

DESERTIFICATION

African nations take UN to task

Countries urge higher priority for drought research.

BY T. V. PADMA

Scientists in African countries are asking the United Nations to help them better identify — and prepare for — drought. Delegates from the continent made the call as the UN Convention to Combat Desertification (UNCCD) concluded its two-week annual meeting, in New Delhi.

African nations are concerned that, 25 years after the convention was signed, there is no consensus among researchers on a precise definition for drought beyond “an abnormal deficiency of water”.

A review of the drought literature published in July found varying definitions, from reduced precipitation to soil erosion (I. J. Slette *et al. Glob. Change Biol.* **25**, 3193–3200; 2019).

But the UN estimates that around 40% of the world's population is affected by water scarcity and that, by 2030, 700 million people will have been forced to leave their homes because of drought. In 2017, some 20 million people in Africa and the Middle East were on the brink of starvation as a result of drought.

Barron Joseph Orr, UNCCD's lead scientist, told the meeting that the secretariat is developing three measures that countries could use to identify drought risk. The first is an assessment of drought hazard that calculates what proportion of a given land area is affected by drought; the second tracks the proportion of people exposed to drought. The third — known as a drought vulnerability indicator — tracks the degree to which communities and ecosystems are at risk from drought.

Stephen Muwaya, an ecologist with Uganda's agriculture ministry, questions the indicators' accuracy. The drought vulnerability indicator, for example, relies on data about the social, economic, environmental and physical causes of drought. But many developing countries do not measure these data systematically, he says.

Ibrahim Thiaw, who heads the UNCCD secretariat, said that 12 million hectares of land becomes degraded every year. Reversing this will require US\$450 billion annually. Between 2017 and 2019, UN member states spent \$6.4 billion on this problem, according to the UN's Global Environment Facility.

“We have woken up to the fact that we will see more frequent and severe droughts, a phenomenon that will be exacerbated by climate change,” Thiaw said. ■



Marine biologist Emma Camp sampling coral.

ROLEY/FRANCK GAZZOLA don't care that the world can go on without people, but I do care that I'm incurring debt on my children that I can never repay," he laments.

Witnessing the Great Barrier Reef “go into meltdown in the space of a week” in early 2016 was a major shock for David Suggett, a coral physiologist at the University of Technology Sydney in Australia. “Nothing can prepare you for seeing it play out in real time,” he says.

Suggett says that he finds it difficult to set aside his emotions about the reef's condition when talking to the public. He worries that if he shows his feelings, then people will accuse him of being biased. “It's very challenging for researchers to maintain the appearance of being objective while showing that they care about the ecosystems they're working on,” Suggett says. He thinks a lack of support networks for scientists struggling with the emotional effects of their work could also lead to feelings of isolation.

For Selina Ward, who studies coral reproduction at the University of Queensland, communicating her research findings to the public adds to her sense of despair. Her work on the reef during the past 30 years has shown that changes in ocean temperature have severely affected the ability of coral larvae to become part of larger reefs. “I try to be positive, but it's a really miserable story,” she says.

COPING STRATEGIES

Recognizing how ecosystem decline and climate-related events can affect mental health is important, says Neville Ellis, a social scientist at the University of Western Australia in Perth. He and Ashlee Cunsolo, who studies environmental change and health at Memorial University of Newfoundland in St John's,

Canada, wrote a commentary last year that introduced the idea of ecological grief as an emotional side effect of environmental degradation (A. Cunsolo and N. R. Ellis *Nature Clim. Change* **8**, 275–281; 2018).

They found that people could mourn the disappearance or degradation of a species or landscape and the future losses of an ecosystem.

EMOTIONAL RISK

Ellis notes that research such as Barnes's highlights the emotional vulnerability of scientists who work at the forefront of an ecological crisis. “By recognizing that such risks exist, research teams can be better prepared to help colleagues that may be suffering from distress,” he says.

More people will be exposed to ecological loss as climate change intensifies, and researchers need a better understanding of how scientists and the public can maintain their well-being in the face of these challenges, says Ellis.

Some scientists have developed their own strategies to cope with the stress and anxiety of their work. Emma Camp, a coral biologist at the University of Technology Sydney, tries to channel her sadness about the diminishing coral reefs into action, such as restoring damaged reefs. “I can either give up when I feel upset, or use those emotions to motivate me and find better solutions.”

Getting involved in side projects can also facilitate a healthier mindset, says Ward. She's started investigating the reproductive patterns of sea hares, a group of molluscs that are more resilient to increasing ocean temperatures than are corals. “It takes my mind off the bad news,” she says. ■