NATURE'S 10

Ten people who helped shape science in 2022.

Jane Rigby / Yunlong Cao / Saleemul Huq
Svitlana Krakovska / Dimie Ogoina / Lisa McCorkell
Diana Greene Foster /António Guterres
Muhammad Mohiuddin / Alondra Nelson

ILLUSTRATION BY MELISSA WEISS

The *Nature*'s 10 list explores key developments in science this year and some of the people who played important parts in these milestones. Along with their colleagues, these individuals helped to make amazing discoveries and brought attention to crucial issues. *Nature*'s 10 is not an award or a ranking. The selection is compiled by *Nature*'s editors to highlight key events in science through the compelling stories of those involved.

Jane Rigby
Sky hunter

This astronomer had a key role in getting the James Webb Space Telescope into space and working properly, providing vast new capabilities to study the Universe.

By Alexandra Witze

Of all the hundreds of things that could have gone wrong with the James Webb Space Telescope (JWST) after it launched on 25 December 2021, Jane Rigby kept thinking of one nightmare scenario. As the US$10-billion telescope unfolded in deep space, it had to deploy a secondary mirror in front of its huge primary mirror so that it could capture and relay the precious photons back to Earth.

"That's the one that scared me the most," says Rigby, who is the telescope's operations project scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "I could just visualize this beautiful telescope, the gold mirrors in space, focusing the light to nothing with no secondary mirror there."

Despite her nerve-wracking vision, the telescope deployed its secondary mirror perfectly, along with all its other components over the course of one month. Rigby then helped lead the work to assess the telescope's performance. The mission succeeded beyond almost everyone's expectations. From the first jaw-dropping images released in July to the discoveries of distant galaxies and exoplanet atmospheres, JWST has dominated astronomy headlines throughout 2022. And of the thousands of astronomers who worked on the telescope over decades, Rigby has been a linchpin.

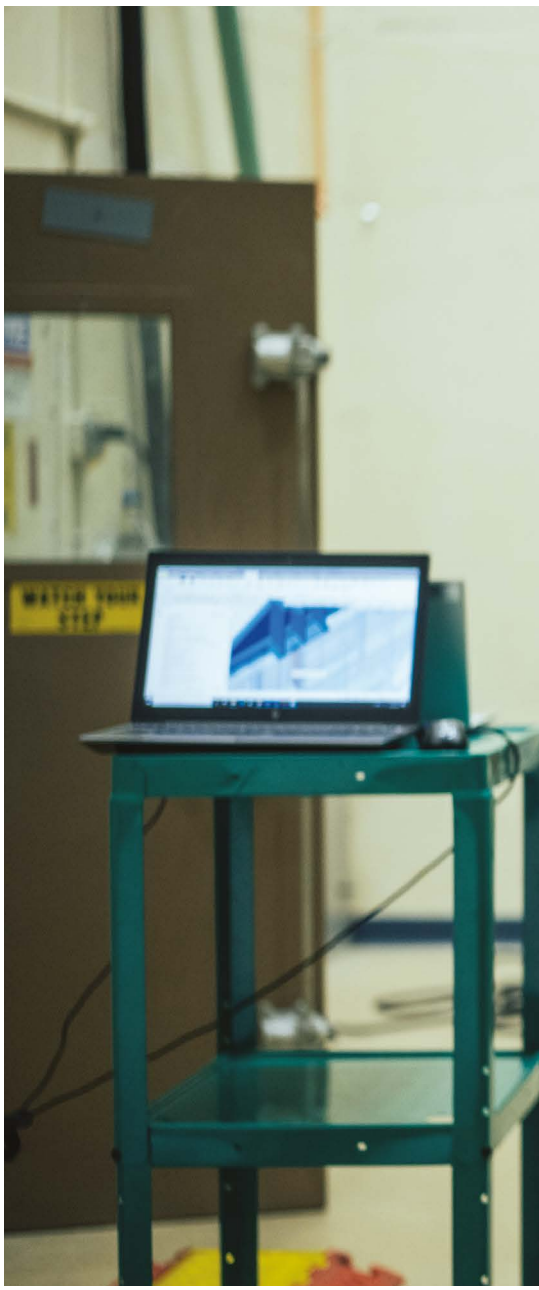
She became an astronomer because she was too short to fly the space shuttle. Growing up in rural Delaware, she watched Carl Sagan's *Cosmos* series on television and read about Sally Ride, the US astrophysicist who became an astronaut. Rigby didn't meet the physical requirements to become a shuttle pilot, so she set her sights on astronomy as a way into space. She bought a second-hand telescope and took it out to the fields at night, and gained hands-on experience of soldering and tinkering with her father, a physics teacher.

As an undergraduate, she dove straight into research, working with data from the Keck telescopes in Hawaii. By the time she started graduate school at the University of Arizona in Tucson, she was analysing observations from NASA's Spitzer Space Telescope, which opened up fresh realms of infrared astronomy. "You put up a telescope that's just so much better than anything we've had before, and you can't help but discover stuff," she says.

Yet it was far from clear that JWST would be a success. The project had dragged on since its conception in 1989, and it was experiencing schedule delays and soaring costs. In 2010, just as all the telescope's problems were compounding, Rigby turned down two other job offers and joined the project. "The science was just so compelling," she says. Part of her job was to work out how to restore the capabilities that had been slashed as its budget ballooned.

Twelve years later, launch day unfolded for Rigby at the Space Telescope Science Institute in Baltimore, Maryland, just as the team had practised time after time. She remembers hearing "there's current on the array", once the telescope had separated from its rocket and extended its solar arrays to generate power. "It's hard to imagine how much joy was in that sentence," she says.

Thus began five months of commissioning the telescope. Rigby had a key role in, among other things, measuring and understanding the background light that leaks into JWST observations because the telescope is not enclosed in a tube, as Hubble is. "She worked extremely hard every day" to drive down the uncertainties in how this background light affected the telescope's data, says JWST project scientist Klaus Pontoppidan at the Space Telescope Science Institute. And that

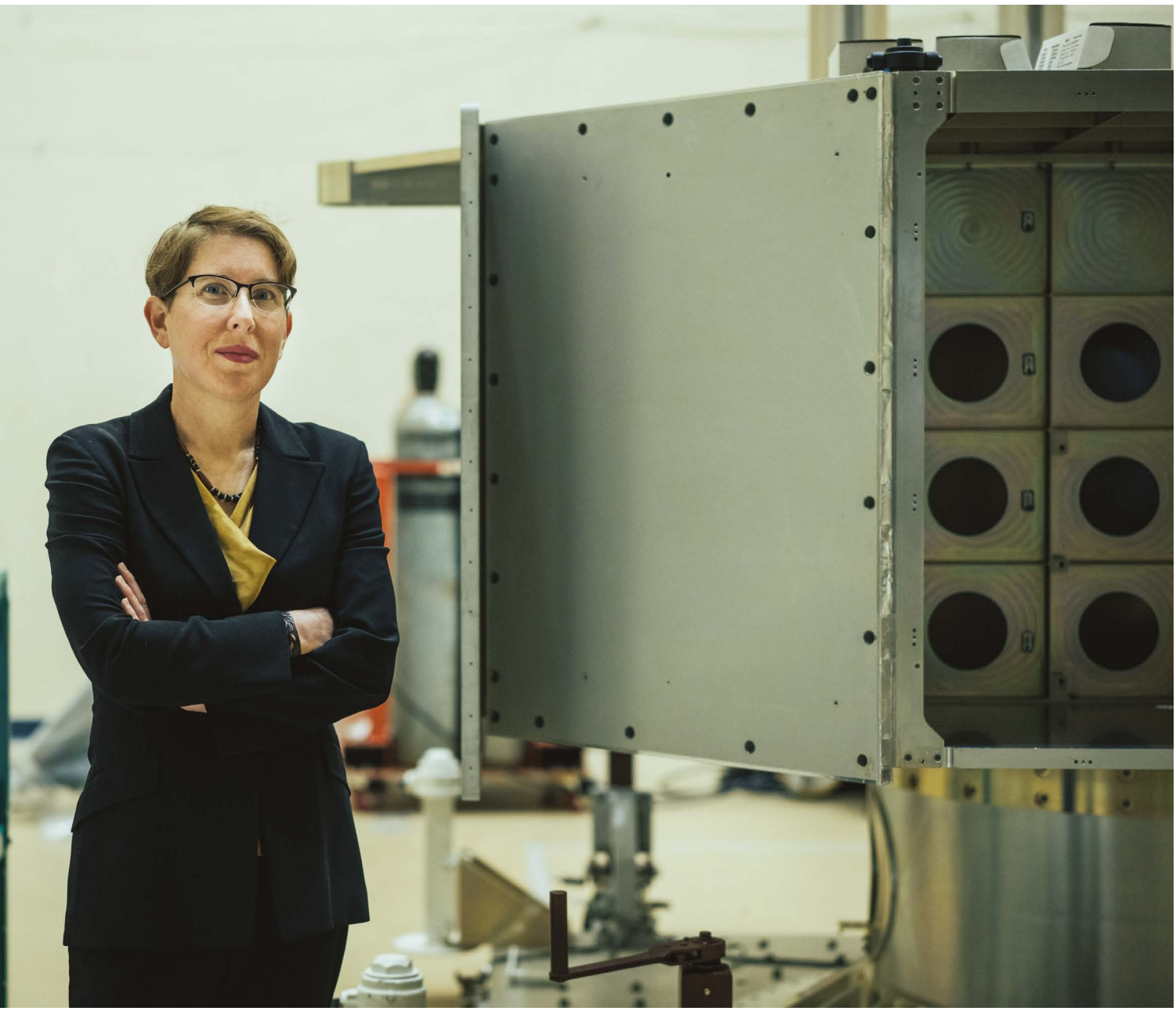


allows astronomers to be confident that their measurements are accurate.

On 12 July, Rigby made the good news public in the first paper on scientific results from JWST. That week, she was at the White House to unveil the telescope's first images with President Joe Biden. Since then, she has been a staple at scientific talks and press conferences about the telescope's results.

One thing she does not want to do is talk

"There's a feeling of belonging, that the Universe doesn't reject me."



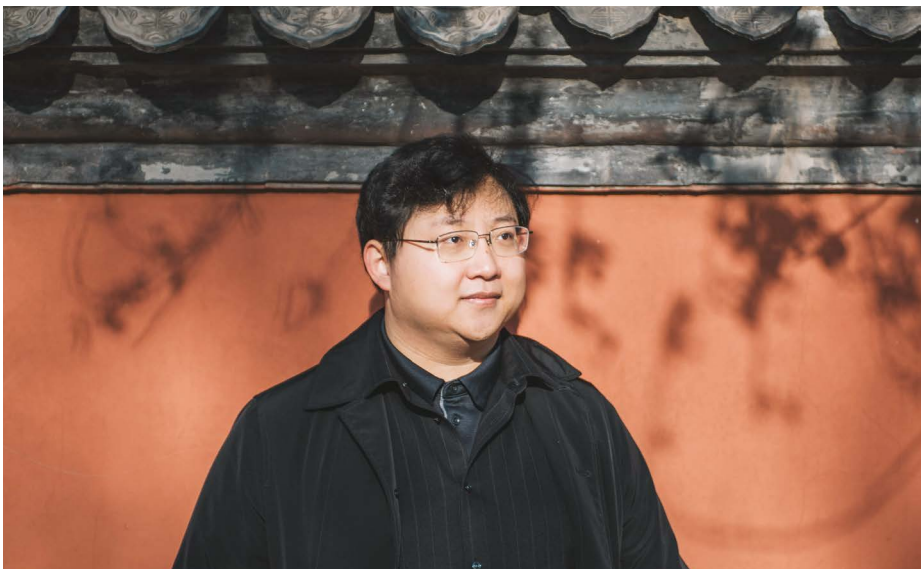
STEPHEN VOSS FOR *NATURE*

about the telescope's name. Rigby identifies as queer, and the name is controversial because it honours James Webb, who had worked in high-ranking government positions at a time when the US government persecuted and fired employees from sexual and gender minorities (LGBT+), including at least one at NASA when Webb led the agency.

Rigby credits her activism in the LGBT+ community with sharpening her leadership in science. As a postdoc in California, she helped to organize voters against a ballot proposition that would have banned same-sex marriage — developing skills such as how to manage and motivate people. One of her role models is Frank Kameny, an astronomer who was fired from the US government in 1957 for homosexuality and who went on to become a crusader for gay rights.

A thread that ties together many LGBT+ people in astronomy, she says, is "there's a feeling of belonging, that the Universe doesn't reject me". Given the risks facing many LGBT+ scientists, that sense of acceptance and safety is crucial, she says. "Certainly for me there was a sense of being drawn to astronomy in part because of my queer identity — that it was a feeling of being part of the Universe, and being part of the bigger story."

Yunlong Cao
COVID predictor



His rich characterizations of emerging variants have allowed researchers to keep step with SARS-CoV-2 as it evolves.

By Ewen Callaway

When Yunlong 'Richard' Cao returned to China in late 2019 from the United States, he hoped to build on his doctoral research in single-cell genomics. But shortly after he settled into his research-associate position at Peking University in Beijing, the city went into lockdown.

Cao and his adviser, biophysical chemist Xiaoliang Sunney Xie, found their laboratory emptied of technicians and students. Confronted with the prospect of stopping work, Cao realized that the methods he had specialized in could be used to study the antibodies triggered by infection with SARS-CoV-2. "I never thought I would pursue immunology and virology," says Cao.

Now, as scientists watch a fresh COVID-19 wave circle the globe — fuelled by a chaotic mix of SARS-CoV-2 variants, descended from Omicron — Cao's work offers a glimmer of hope for staying half a step ahead of the virus's wild evolution. By probing people's antibodies in exquisite detail, his team has managed to predict many of the mutations that define this 'variant soup'.

"It's been an absolute tour de force," says Laura Walker, an immunologist and chief scientific officer at the biopharmaceutical company Invivyd in Waltham, Massachusetts, who has also been trying to predict Omicron's evolution. "They've been putting us to shame with the depth and breadth of their studies."

Cao — who leads much of the COVID-19 work in Xie's group — started his pandemic efforts by screening people who had recovered from COVID-19 for antibodies that could be used in treatment. Working with a Chinese drug company, the group picked two of the most potent infection-blocking, or neutralizing, antibodies and began trialling them in people with COVID-19.

Early results looked good, but the drug company halted development after scientists in South Africa identified the Beta variant in late 2020. This immune-evading variant harboured mutations that made it impervious to one ingredient of Cao's antibody cocktail and blunted the potency of a second. "I started to think, 'Damn, there must be a better way to do this,'" Cao says.

He wondered whether, instead of creating therapies based on the strongest antibodies, he could identify which antibodies were most resilient to viral change. He was inspired by a study that described how nearly every possible change to the receptor-binding domain of the SARS-CoV-2 spike protein — roughly 4,000 amino-acid combinations — affected its ability to attach to host cells and infect them.

But that study — led by evolutionary virologist Jesse Bloom at the Fred Hutchinson Cancer Center in Seattle, Washington — involved just one protein. Cao wanted to do the same type of study to track how the virus might evolve to evade hundreds, even thousands, of antibodies. This would take years using conventional techniques, Cao says, so he developed a high-throughput method to do it in weeks.

The effort showed, in fine detail, how the virus could respond to antibody pressure. It also identified the mutations that provide the most bang for buck in dodging immunity. And the approach allowed Cao's team to study how exposure to different variants affects the antibodies that people produce. For instance, those who had recovered from Omicron BA.1 made neutralizing antibodies that could be overcome by spike protein mutations present in Omicron BA.5, which swept the world in the first half of this year.

Cao's team predicted the key mutations that would define many of the variants currently circulating, by studying antibodies from people who had recovered from BA.5, its ancestor BA.2 and earlier variants. These forecasts allowed the team to assess variants' abilities to evade immunity shortly after they'd been identified, and often weeks before other teams. "This is the first time, I believe, we are ahead of the virus," Cao says.

His team has been on the bleeding edge of generating experimental data on new variants, says Bloom, as well as rapidly sharing that information through preprints, social media and virus-tracking websites.

Cao and his colleagues are now looking to design new antibody therapies, identifying those that are most resilient to viral evolution. Cao says he's guided by his undergraduate background in physics as he tries to stay ahead of the virus: "Only by making predictions that work does this show you understand the system," he says.

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Saleemul Huq
Climate revolutionary

"It was an absolute red line. We were ready to walk."

This climate researcher from Bangladesh helped to force wealthy countries to pay for the losses and damages from climate change.

By Ehsan Masood

In the final hours before the close of last month's United Nations climate conference in Egypt, exhausted delegates slumped on sofas outside the formal meeting rooms. But not Saleemul Huq, who was sitting upright, rapidly checking messages on his phone.

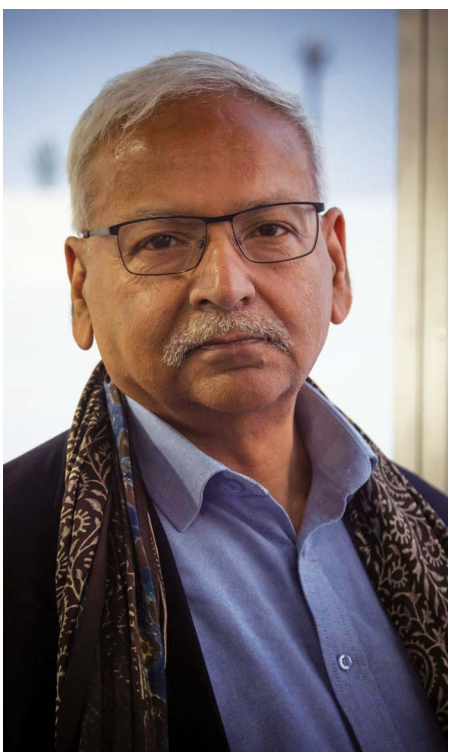
The meeting's final text had yet to be agreed. But Huq told *Nature* he was confident that negotiators from the world's governments attending the conference would agree to a new kind of climate fund: one that would cover the costs of the 'loss and damage' suffered by climate-vulnerable countries. "Don't worry," he said. "It's in the bag."

And so it was. The final agreement signed in the Red Sea resort town of Sharm El-Sheikh includes a commitment to establish a loss-and-damage fund to help lower-income countries deal with the impacts of climate change. That provision is the culmination of a nearly 30-year campaign to get the world's historically high carbon emitters to acknowledge they have some financial responsibility to low-emitting countries that face devastation as temperatures continue to rise. And for more than a decade, that movement's unofficial leader has been Huq, originally a plant biologist who now directs the International Centre for Climate Change and Development in Dhaka.

"Loss and damage isn't aid," says Huq. It is based on the 'polluter pays' principle, and that, says Huq, is why it has been opposed since before the 1992 Earth Summit in Rio de Janeiro in Brazil, which gave rise to today's climate agreements. "When money is given as aid, all the power rests with the donor." It's an unequal relationship, he adds.

Huq's experience with the turmoil of international politics started young. He was born in Karachi to parents in Pakistan's diplomatic service, before East Pakistan broke away from West Pakistan to become independent Bangladesh after the 1971 war of liberation. His parents, who opted for Bangladesh, escaped capture by Pakistan's military by travelling overland on a donkey to India through Afghanistan.

Growing up in Europe, Africa and Asia through his parent's diplomatic postings, he developed a passion for science and moved to London 50 years ago to study biochemistry, eventually doing a PhD at Imperial College London. Huq later returned to Bangladesh and co-founded, with Atiq Rahman, the Bangladesh Centre for Advanced Studies (BCAS), an independent think tank focused on environment policy. Bangladesh has a long history of environmental disasters, especially flooding. Huq and his colleagues persuaded their government that it needed an environment department, and that BCAS would be its thinking and research arm. BCAS helped the department to write Bangladesh's first environmental action plan, says Mirza Shawkat Ali, the government's director for climate change.



SIMA DIAB FOR *NATURE*

Huq led the establishment of a worldwide network of experts who work in a branch of development called community-based adaptation, says Lisa Schipper, a climate researcher at the University of Oxford, UK. This long-standing idea, pioneered in Bangladesh, focuses on helping rural communities to find their own research-based solutions to problems, such as improving flood defences or adjusting cropping patterns in response to climate change.

The communities, Huq says, "need to be in the driving seat".

By the 1990s, he had become active in international climate negotiations, as an adviser to climate-vulnerable countries, especially small island states, helping them to put their needs on the agenda in UN talks. The idea of funding for loss and damage gained traction in the years leading up to the 2015 Paris climate agreement, says Achala Abeysinghe, an environmental lawyer now at the Global Green Growth Institute in Seoul, who worked with Huq advising climate-vulnerable countries. Huq's strategy, she says, was to persuade more countries (including China and India) of the case for loss and damage "so the least developed countries and small island states are not alone". But persuading the high-emitting wealthy countries was a tougher task.

An early breakthrough came at the 2015 Paris talks. Article 8 of the final agreement explicitly uses the term: "Parties recognize the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change." But getting those words into the text needed nerves of steel, Abeysinghe says. "We were told that if we insist on including loss and damage, we would be blamed if the treaty failed. But it was an absolute red line. We were ready to walk."

Huq faced the same response from the European Union and the United States at Sharm El-Sheikh. But once again, the advocates of loss and damage held firm as some of the world's wealthiest nations pushed to keep the commitment out of the treaty, says Huq. "We didn't blink."

Svitlana Krakovska
Voice for Ukraine

An IPCC scientist became an international advocate for her country and linked Russia's invasion to climate change, calling it a 'fossil-fuel war'.

By Aisling Irwin

On the morning of Thursday 24 February, Svitlana Krakovska could hear missiles falling in nearby parts of Kyiv while she sat in her apartment attending a video conference with representatives of 93 countries. The delegates to the meeting of the United Nations Intergovernmental Panel on Climate Change (IPCC) were finalizing their highly anticipated report on the impacts of the warming world. Krakovska, head of Ukraine's delegation, didn't know what to do. Should she use the meeting to protest against the Russian invasion going on around her?

"I understood that the IPCC is not a political body, and I didn't want to undermine it," says Krakovska, who runs the Applied Climatology Laboratory at Kyiv's Ukrainian Hydrometeorological Institute. "But this was an exceptional situation."

The bombings forced Krakovska to drop out of much of the IPCC meeting; with her husband and four children, she was making preparations to survive the war. But after deliberating for three days, and despite being "pretty shy", she decided to speak at the closing plenary. "I was so angry," she says.

"This human-induced climate change and war against Ukraine have direct connections and the same roots: they are fossil fuels and humanity's dependence on them," she told delegates. "The ease of receiving energy from burning coal, oil and gas has changed the balance of power in the human world."

The response was overwhelming. Delegation after delegation voiced solidarity with Ukraine, including the representative of Russia, Oleg Anisimov, who apologized for the attack.

"I was in tears," says Krakovska. "At that moment, we so much needed this support." She later received calls and private messages — tens of them every day, she says. Some researchers offered her refuge and scientific positions elsewhere.

Krakovska and her family have not moved from Kyiv, partly because her father was seriously ill and in a care home, before he died in April. But the international attention that followed the IPCC meeting has changed her life. A friend persuaded her to accept invitations to speak at major events around the world. That has launched Krakovska into the public eye as a campaigner both for climate action and for Ukraine; she has called Russia's invasion a "fossil-fuel war".

Krakovska did not start her career in climate science: her first IPCC meeting was only nine years ago, in Stockholm in 2013. Born in Kyiv in 1969, she studied meteorology in Leningrad (now St Petersburg, Russia) and became a cloud physicist, working on cloud-seeding experiments to enhance precipitation in the Ukrainian steppes. In her spare time, she climbed every mountain system in the former Soviet Union.

As a postdoc in the 2000s, she discovered the incipient field of regional climate modelling and became the first Ukrainian scientist to apply it to her country. She found that many in Ukraine — including some scientists — dismissed the threat of climate change, either saying they didn't believe it, or arguing that it wouldn't have much impact in a country far from oceans, tropics or polar regions.

At the 2013 IPCC meeting, she was impressed to see how rigorous science can be rendered understandable to policymakers. And when the scientists spoke, everyone was listening. "I'm not used to being listened to so carefully."

Krakovska persuaded other Ukrainian scientists to join the IPCC, including Yakiv Didukh, an ecologist at the M. G. Kholodny Institute of Botany in Kyiv, who praises her "charisma" and "modesty".

The experience boosted scientists' domestic influence: last October, Ukrainian senior ministers approved a strategy for environmental security and adaptation to climate change up to 2030.

After the meeting in February this year, Krakovska left Ukraine to speak at events including the European Geosciences Union in Vienna and the World Economic Forum's annual gathering in Davos, Switzerland. In September, she chaired a meeting, virtually, on rebuilding Ukrainian science at the UN General Assembly in New York City. She also attended side events at the COP27

"I was in tears. We so much needed this support."

JOSEPH SYWENKYJ FOR *NATURE*

climate conference in Sharm El-Sheikh, Egypt, saying that the world should emulate Ukrainians' determination in the war against Russia to fight climate change.

Back in wintry Kyiv, Krakovska is struggling with intermittent electricity, heat and water — while missiles have continued to land kilometres from her home — but she is thankful for amenities such as a mobile-phone connection, albeit weak. She continues to work on climate-change projections for Ukraine and hopes to convene postponed webinars explaining the IPCC reports. She is spending the fees she earns from international work and speaking engagements on purchasing electricity generators for other Ukrainians.

Around her, Ukraine's citizens, including scientists, are struggling. Some 131 Ukrainian universities and colleges have been damaged in the war and 22 destroyed; more than 50 research institutions are either damaged or destroyed, says Olga Polotska, executive director at the National Research Foundation of Ukraine in Kyiv. Laboratory equipment has been stolen, too, Polotska adds, including more than US$10 million worth of kit from the Chernobyl nuclear power plant. And around 1,300 scientists affiliated with the National Academy of Sciences of Ukraine have left the country.

For those scientists in Ukraine who can still do work, Krakovska adds, "it's very difficult when you need to think about survival".

Ko Barrett, an IPCC vice-chair and a senior adviser for climate change at the US National Oceanic and Atmospheric Administration in Washington DC, praises Krakovska's decision to speak up in February. "We're scientists, but we're humans," she says. "There's nobody who stands where she stands who can tell the same story".

Dimie Ogoina
Monkeypox watchman

This Nigerian scientist's research helped the rest of the world to combat the virus.

By Max Kozlov

When Dimie Ogoina first heard in May that monkeypox was spreading around the globe, he felt a certain sense of déjà vu. The virus had turned up in his home country of Nigeria in 2017 for the first time in nearly 40 years and led to more than 700 confirmed and suspected cases.

During that outbreak, Ogoina, an infectious-disease physician at Niger Delta University in Amassoma, was the first person to diagnose someone with a confirmed case of the disease, which was renamed mpox by the World Health Organization in November to reduce stigma.

As with the current outbreak, which has now caused more than 82,000 infections and 65 deaths globally, the Nigerian epidemic in 2017 seemed to be concentrated in urban areas and among young and middle-aged adult men. This was different from previous transmission patterns for mpox, which typically showed up in rural areas and in children, often as a result of contact with infected wildlife.

Ogoina was instrumental in detailing the pathogen's spread in Nigeria, noting the uncharacteristic genital legions it caused and the fact that children seemed to be spared, even in some households where there were infections. In 2019, on the basis of this evidence, he and his colleagues argued that the virus might spread through sexual contact, and that it could spread much more efficiently between people than previously thought. His efforts to convince his colleagues of this, however, were met with little success at the time. "People did not want to take it seriously," he says.

Although it is still unclear whether the virus is sexually transmitted in the strict sense — passed through blood, semen or other bodily fluids — it is clear that it transmits readily through sexual contact. Ogoina's mpox research has been cited hundreds of times since the beginning of the global outbreak. It tipped off health officials about the role of sexual contact, and helped to accelerate the development of education and vaccination campaigns in high-income countries, according to Anne Rimoin, an epidemiologist at the University of California, Los Angeles, who has been involved in efforts to track and contain mpox in the Democratic Republic of the Congo for more than 20 years. "Dimie has been a leader in the field," she says, adding that his "discovery was very important and should have been a red flag to the world".

"He is very focused, and he's a go-getter."

Mpox was not Ogoina's first foray into viruses. Since becoming an infectious-disease physician more than a decade ago, he's been at the forefront of Nigeria's research into a raft of other communicable diseases, including HIV/AIDS and Ebola. "He is very focused, and he's a go-getter," says Rosemary Audu, a virologist and head of research at the Nigerian Institute of Medical Research in Lagos.

But now, even though the global outbreak is waning — there are on average fewer than 100 new cases each week globally, down from about ten times that rate in August — the situation on the ground in Nigeria has not changed significantly. The drugs, vaccines and surveillance resources that have helped to control the virus's spread in high-income countries remain out of reach in West and Central Africa.

There has been a whirlwind of publications about mpox over the past year, but Ogoina says he worries that the new attention and funding for mpox will soon dry up, and that the disease will revert to spreading just in countries in central and western Africa.

So, he has made it his personal mission to better understand the disease's spread in Nigeria, and to stop it. The country has confirmed 624 infections so far in 2022, but Ogoina thinks that this is a "gross underestimation". He says that without a clear understanding of who is becoming infected with the virus, and how they're becoming infected, Nigerian health officials are working "completely blindly" to contain it.

And he warns the rest of the world against continued complacency about mpox's spread in Africa — otherwise it will be déjà vu all over again. "The virus will come back," he says.

EMEKE OBANOR FOR *NATURE*

Lisa McCorkell
Long-COVID advocate

"We are trying to put patients at the forefront of all types of research."

Even as the condition affects her daily life, this researcher is putting patients at the centre of long-COVID research.

By Heidi Ledford

As a graduate student, Lisa McCorkell studied how to take on some of the biggest challenges in social policy, including food poverty and social safety nets. But there was one subject she steered clear of: health care. "I felt like it was too complicated," she says. "I was trying to stay away from that."

These days, she spends much of her time enmeshed in health-care policy. After a mild bout of COVID-19 in 2020, she contracted a debilitating case of long COVID, which continues to affect her daily life. Later that year, she and four other women with the condition founded the Patient-Led Research Collaborative, a group of researchers who conduct and inform studies into the condition.

This year, even as the pandemic slips off the agenda in many countries, the collaborative has continued to grow its membership and its impact. It has introduced a US$4.8-million fund for research projects, with grantees selected by a panel of people with long COVID. McCorkell has helped to shape pivotal studies of long-COVID; last year, she testified before the US Congress on the needs of people with the condition. "We are trying to put patients at the forefront of all types of research," McCorkell says. "We have patients determine what our research priorities are, and make the final decision on where this money is going."

The collaborative's approach feels particularly fitting for long COVID: from the start, patients have often had to advocate for their own medical care and design their own treatment regimens. The confusion and fear was tremendously isolating, says Letícia Soares, who works for the collaborative from Salvador in Brazil. "Connecting to others who were doing the same was really the only way through it both emotionally just to survive and to see a path forward," she says.

To travel that path, McCorkell and her collaborators, frustrated that key studies of the condition were not being done, decided to do the research themselves. In 2020, they conducted a survey of people's experiences with long COVID, and set up a Google Doc to share the results. "It got quite a bit of attention and helped put long COVID on the map as an issue," McCorkell says.

The collaborative and its studies have since outgrown Google Docs. Last year, the group published a landmark report that documented more than 200 symptoms. Members of the collaborative have served on advisory boards for long-COVID research projects, including the US National Institutes of Healths' $1-billion Researching COVID to Enhance Recovery (RECOVER) initiative. "What they've been able to do in such a short period of time has been outstanding," says Kelly O'Brien, a physical therapist at the University of Toronto in Canada, who has collaborated with the group on a study about symptom fluctuations. McCorkell and co-founder Hannah Wei have been instrumental in refining the study to make it more feasible for people living with long COVID to participate, she says.

There are ongoing studies on the impact of SARS-CoV-2 reinfection on long-COVID symptoms, and an initiative to study the condition in low- and middle-income countries. This year, the collaborative began to distribute the $4.8 million it was awarded by Balvi, a fund established by cryptocurrency entrepreneur Vitalik Buterin to support high-impact COVID projects. Among the study topics are post-exertional malaise and microclots.

The collaborative's staff keep flexible hours to account for recurring symptoms, says Soares, who left her post as a wildlife researcher because of the lack of accommodations for her disability. "We have a work style that is very asynchronous and prioritizes people's health above everything," McCorkell says.

Meanwhile, McCorkell's own agenda is evolving. As she liaised with government agencies, including the US Centers for Disease Control and Prevention, she realized that people with long COVID are part of a much wider community of disabled people in need of a voice. "I'm hopeful that we'll be able to move into the future by taking disability justice as a lens to any policymaking."

MARISSA LESHNOV FOR *NATURE*

Diana Greene Foster
Abortion fact-finder

After the US Supreme Court allowed states to ban abortion, this demographer set out to track the consequences.

By Cassandra Willyard

Diana Greene Foster was at the annual National Abortion Federation conference in Orlando, Florida, when a leaked draft decision revealed the US Supreme Court's intention to overturn *Roe* v. *Wade* in May. "My phone just blew up," says Foster, an abortion researcher and demographer at the University of California, San Francisco.

The decision wasn't entirely unexpected. In fact, Foster had been so concerned that the court would undermine the landmark 1973 ruling that protected access to abortions, that she had already started planning a study to look at the impacts in those states most likely to ban the procedure. But it still felt like a punch to the gut. "I was hoping that the study would never need to be done," she says.

Foster noticed that the draft decision did not mention the wealth of research on abortion outcomes that she and others had already presented to the court, and she vowed to ensure that scientific evidence would become part of the conversation. She spent the entire next day on the phone to reporters.

For more than two decades, Foster has studied access to contraceptives and the effectiveness of family-planning programmes. But the study she is best known for looked at the impact of abortion — or being denied one — on a person's mental, physical and economic health. Known as the Turnaway Study, it was inspired by an offhand comment she remembers hearing from an abortion provider in 2006: "I wonder what happens to the women we turn away?"

Foster realized that, by tracking the outcomes for people who are denied abortions, she could finally answer the question of whether abortions cause harm. Previous studies had looked at the outcomes for people who have children and those who have abortions. But "the only reasonable comparison group is people who want [abortions] and can't get them", Foster says. No one had made that comparison before.

"We hadn't really come up with a rigorous way to document how people were impacted by the abortion itself," says Lauren Ralph, an epidemiologist at the University of California, San Francisco, who worked with Foster on the study. "She really came up with this beautiful and innovative design."

Foster and her team convinced 30 abortion providers around the country to recruit women who came to clinics and received an abortion, as well as those who had missed a facility's designated cut-off and were denied the procedure. The Turnaway Study tracked how nearly 1,000 women fared for up to 5 years.

Through more than 50 peer-reviewed papers, the study has shown that receiving an abortion does not harm a woman's health or well-being. Being denied an abortion, however, leads to negative financial and health outcomes, and harms families. Those who are denied an abortion are more likely to live in poverty, raise their children alone and experience life-threatening complications related to the birth of that child.

One analysis, for example, matched a

"She's a true scientist. She's ready to hear — and willing to hear — unwelcome results."

DON FERIA FOR *NATURE*

subset of the Turnaway participants to their credit scores, and showed that women who were turned away from abortion clinics experienced much higher financial distress than those who were granted access (D. G. Foster *et al. Am. J. Public Health* **108**, 407–413; 2018). They also faced an increase in negative events such as bankruptcies and evictions.

Caitlin Knowles Myers, an economist at Middlebury College in Vermont, was initially sceptical about the Turnaway Study's design. She suspected that people who seek an abortion after it is too late might already be in financial trouble. But Foster's credit-score analysis showed that the two groups were similar "right up until that pivotal moment in their lives", Myers says. "Then they diverge dramatically."

Foster's next study, which launched just days after *Roe* v. *Wade* was officially overturned in June, will compare people who managed to get an abortion up to two weeks before individual state bans came into effect with those who planned to get an abortion but couldn't. In the Turnaway Study, those who were denied an abortion had few other options for ending their pregnancy. "But with these bans, the question is who's actually able to circumvent their state laws," Foster says. This study will also account for transgender and non-binary people seeking an abortion; these individuals were not tracked in the Turnaway Study.

Katie Watson, a lawyer and bioethicist at Northwestern University Feinberg School of Medicine in Chicago, Illinois, has always been struck by Foster's relentless pursuit of the facts. "She's a true scientist. She's ready to hear — and willing to hear — unwelcome results." And when policymakers and activists make assertions without evidence to back them, "her life's work is to fact check them", Watson says.

Foster hopes that the evidence she gathers in the coming months will help policymakers as they decide whether to change the restrictions on abortion in their own states. The Supreme Court might have ignored the science, but Foster hopes that states won't. "I am absolutely determined that, when it gets decided at the state level, they have the data about what the consequences will be for families."

António Guterres
Crisis diplomat

The secretary-general of the United Nations has embraced his role as the world's conscience.

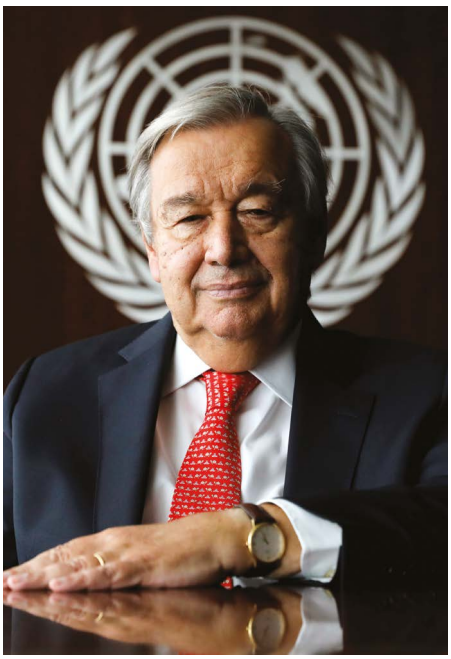
By Anita Makri

United Nations secretary-general António Guterres had fierce words for world leaders who gathered for the UN climate summit in November. "We are on a highway to climate hell, with our foot still on the accelerator," he said as the meeting kicked off in Egypt. His message was just as blunt as the negotiations concluded without meaningful extra progress towards cutting greenhouse-gas emissions. "Our planet is still in the emergency room," he told delegates.

Bold public statements that serve as a voice of conscience for humanity have become a feature of Gutteres's leadership. He calls failings as he sees them. The "world is a mess", he told the BBC in 2015, while he was the UN high commissioner for refugees.

Much of that vocal advocacy centres on environmental issues, serving the interests of low-income countries and setting global priorities. But his low-profile diplomacy behind the scenes also helped to avert a food crisis this year, according to insiders.

During Russia's ongoing invasion of Ukraine, the hostilities have prevented shipments of millions of tonnes of grain from the two countries, which normally account for at least 30% of all wheat, barley, maize (corn) and sunflower oil exported to global markets. Some 90% of the exports from Ukraine typically go through the Black Sea, but when hostilities blocked shipping, they risked causing food prices to soar and threatened millions of people with hunger.



Working with external partners, Guterres and other UN officials helped to broker politically delicate negotiations to set up a protected corridor for grain shipments. The Black Sea Grain Initiative was signed in Istanbul, Turkey, on 22 July.

"A lot of ducks had to be lined up not just by him personally, but by a number of other officials," says David Malone, rector of the United Nations University in Tokyo. "In spite of some harsh words back and forth, he did go to Moscow and made his case to President Putin, and doubtless his intervention was one of the factors that weighed in."

Food prices fell by as much as 10% after the agreement was signed, and since then, nearly 11 million tonnes of grain and other food items have passed through the Black Sea. After a nerve-wracking moment in late October when Russia briefly pulled out, an extension to the deal was secured in November with help from Guterres.

The feat is testament to the power of "discreet diplomacy in finding multilateral solutions", Guterres tweeted. It also counters critics who had labelled his approach to tackling the world's complex crises as overly cautious, marked by words instead of deeds.

Guterres came by his negotiation skills through a long career in public service: he previously served two terms as prime minister of Portugal.

As part of his second term as UN secretary-general, he aims to establish an official science-advisory mechanism to improve decision making at the top of the UN's executive branch. And along with the internal reforms, he continues to press world leaders to tackle global problems. "Guterres is a forceful and important voice on climate change and biodiversity," says Måns Nilsson, executive director of the Stockholm Environment Institute. "He uses his convening power to mobilize heads of government and also businesses on climate-change action in particular."

As the countries were locked in the climate negotiations in November, Guterres was pushing nations at the G20 summit in Bali, Indonesia, to adopt a Climate Solidarity Pact that would commit wealthier nations to helping to accelerate the global transition to renewable energy. Even with all the challenges facing the world, Guterres continues to see hope in the future. As the global population topped eight billion people in November, he said, "I never bet against human ingenuity, and I have enormous faith in human solidarity."

ONES TO WATCH 2023

Sherry Rehman
Minister of climate change, Pakistan
This climate-justice advocate will be looking to build on the commitment to establish a loss-and-damage fund agreed at the 2022 climate negotiations in Egypt.

Nallathamby Kalaiselvi
Indian Council of Scientific and Industrial Research
This electrochemist is the new head of the largest network of research laboratories in India, and the first woman to lead it.

Sun Chunlan
Chinese Communist Party
This vice-premier leads China's response to the COVID-19 pandemic and will play a major part in the country's plans to loosen restrictions.

ANDREW KELLY/REUTERS

Muhammad Mohiuddin
Transplant trailblazer

"I lived and died with that patient."

ROSEM MORTON FOR *NATURE*

This surgeon and his team transplanted the first gene-edited pig heart into a human.

By Sara Reardon

On a snowy night in January, Muhammad Mohiuddin slept in his office at the University of Maryland School of Medicine in Baltimore, unwilling to risk the hour-long drive to his home. If the weather worsened, the transplant surgeon worried he could miss a historic procedure scheduled for the next morning: the first transplant of a gene-edited pig heart into a human.

The surgery would realize decades of work by Mohiuddin and others, who aim to establish pigs as a source of organs for people waiting for transplants. Xenotransplantation, as the process is known, was first proposed centuries ago, but was largely abandoned when it became clear that human bodies quickly reject organs from other species. Over the past decade, however, advances in gene-editing technology have allowed researchers to remove specific pig proteins and sugars that trigger the human immune system, making the organs more compatible. Several companies began raising modified pigs for this purpose.

Like many other scientists, Mohiuddin had applied to the US Food and Drug Administration (FDA) for permission to test xenotransplantation in a clinical trial. The regulators kept asking for more data from studies of genetically modified pig organs in non-human primates. (The FDA says it does not comment on individual applications.)

Then, in December 2021, Mohiuddin and surgeon Bartley Griffith, also at the University of Maryland School of Medicine, found a workaround. A 57-year-old man, David Bennett, had been bedridden for two months while his heart slowly failed. He was also ineligible for a human heart and certain to die soon. Mohiuddin and his team realized that Bennett's circumstances made him eligible for experimental treatments — including xenotransplantation.

Bennett agreed to the procedure, and Mohiuddin and his colleagues spent the next few weeks sending the FDA data from more than a dozen of their experiments transplanting pig organs into baboons. The team then needed approval from ethicists, funding from the university system and blood samples from all involved (taken before and after the procedure), to ensure that no one had been infected by pig pathogens. Four psychiatrists verified that Bennett was mentally sound when he signed the consent form.

Finally, on New Year's Eve, the FDA approved the emergency procedure and the team scheduled the surgery for 7 January. In the weeks after the operation, multiple infections weakened Bennett's already fragile state. Later, the team would learn that the pig heart had been infected by an undetected pig herpesvirus, although it is unclear whether that affected Bennett's health.

The news of the transplant surprised and elated researchers around the world. "This is a major step forward for the field and a wonderful achievement for a very sick patient," wrote Wayne Hawthorne, president of the International Xenotransplantation Association, in a commentary in the journal *Xenotransplantation*. Even though Bennett died two months after the surgery, he survived longer than anyone had realistically expected, including Mohiuddin. "I lived and died with that patient," he says. "I wanted him to live forever — that was in my heart — but in my head, I knew it would be a miracle."

Mohiuddin says his team has received occasional criticism from animal-rights groups and other researchers regarding the choice of recipient. "There are a lot of opinions, but we have the data, which we think is better than not having that data." Many scientists and transplant surgeons, however, welcomed the news as a milestone that granted legitimacy to the field.

Mohiuddin is open to performing more emergency heart xenotransplants and hopes to begin larger clinical trials, but it is unclear when that will happen. In June, the FDA held a meeting with scientists and companies to outline their concerns around xenotransplantation. The chief issue is patient safety, particularly the potential for infection with pig viruses.

But Mohiuddin's experiment, together with several recent studies in which pig hearts and kidneys were transplanted into brain-dead individuals without being rejected, have made researchers hopeful. "I never imagined this would happen in my lifetime," Mohiuddin says.

DEE DWYER FOR *NATURE*

Alondra Nelson
Policy principal

At the helm of the White House science-policy office, this social scientist made strides for equity, integrity and open access.

By Jeff Tollefson

When Alondra Nelson took charge of the US Office of Science and Technology Policy (OSTP) in February, the agency was in disarray. Her predecessor, biologist and mathematician Eric Lander, had just stepped down amid allegations of bullying and workplace harassment, and the once-obscure office was suddenly in the public spotlight as beleaguered staff members aired their grievances in the national media. Nelson's message as acting director in those early days was simple: let's get back to work.

"It was a calm recentering of why we were there, what our purpose was and how we should relate to each other," says one staff member who asked to remain anonymous because they are not authorized to speak to the media. "It was just what we needed at that moment."

A sociologist at the Institute for Advanced Study in Princeton, New Jersey, Nelson built her reputation probing the social and racial implications of science and technology. It was that expertise that the White House sought when she was appointed as the OSTP's first-ever deputy director for science and society in 2021. The office's primary duty is to coordinate scientific policies across the federal government, and for many social scientists, Nelson's appointment was a sign that US President Joe Biden was ready to make good on his campaign promise to tackle racism and inequality.

For Nelson, who was working on a book about the OSTP before joining the agency, it was a chance to put her research to work. She says the Biden administration has a historic opportunity to promote equity through federal policies and bolster scientific integrity across agencies. "It's an exciting time to be in government," she says.

Nelson has led efforts on scientific integrity and worked on the Blueprint for an AI Bill of Rights, released in October, which lays out basic principles for promoting racial and social equity, enhancing transparency and protecting privacy in artificial-intelligence (AI) technologies. She also shepherded the Biden administration's biggest — and most controversial — science guidance thus far, a call for all federal agencies to ensure that the research they fund is fully accessible to the public the moment it is published.

"She had a procedure for things, which was impressive but also made you sit up a little taller."

Building on 2013 White House guidance that required scientists funded by about 20 government agencies to make their research findings freely available within one year of formal publication, the new policy eliminates the one-year grace period and applies to all government agencies. Although the OSTP had been working on the policy for years, the announcement took some by surprise. Advocates of open access lauded the action, saying it could inject momentum into a growing global movement. But the reaction was different among science publishers, who are facing the transformation of their industry.

Many journal publishers — including Springer Nature, which publishes *Nature* — expressed cautious support, but the American Association of Publishers (AAP) blasted the policy, arguing that it was developed without any meaningful engagement of the science-publishing industry. (*Nature*'s news team is editorially independent of its publisher.) Nelson maintains that stakeholders in publishing were consulted, but the AAP's admonishments were echoed in Congress. In an October letter to the OSTP, Democrat and Republican leadership on the House of Representatives science committee cautioned that the government must not only ensure that federally funded research is available, but do so "in a way that avoids unintended consequences and maximizes the scientific benefits".

Some insiders have raised concerns about whether Nelson did enough to stand up to Lander early on, when more junior staff were being mistreated. "She was in the room" when it happened, says one government official who is familiar with the situation. But Nelson's supporters place the blame squarely on Lander, arguing that the power differential was too large for her to overcome on her own.

Nelson declined to answer questions about Lander's tenure, except to say that, after his departure, "we had to do some work to get the culture of OSTP back to a place where we could focus on the science, on the technology and on the policy".

She returned to her original post in October, after physicist Arati Prabhakar was sworn in as both OSTP director and White House science adviser (the latter post had been temporarily held by Francis Collins, former director of the US National Institutes of Health).

Many have grand hopes for what Nelson can still accomplish. Those who know her or have worked with her say she listens, remembers names, works long hours and has a knack for bringing out the best in her colleagues. Her family's military background often seeps through as well.

"She had a procedure for things, which was impressive but also made you sit up a little taller," says Rebecca Gluskin, who worked with Nelson as a data scientist at the Social Science Research Council, a non-profit organization in New York City.

Nelson says she's focused on the work at hand, and is still excited to do it. Even two years in, she says, "I pinch myself every day."

Correction

The profile on Alondra Nelson erroneously stated that she returned to her original post at the US Office of Science and Technology Policy in September. In fact, she did not return until after Arati Prabhakar was sworn in as OSTP director in October.

Corrected 5 January 2023