"What I feel is hope — hope that we can work together" and that these meetings move beyond good intentions, Bastías says.

Another area for hope among scientists is that Boric plans to address global warming by declaring a climate emergency in Chile. Each year for more than a decade, rainfall has been below average in the centre of the country. Combined with record high temperatures, the trend has led to a series of dry years that researchers have called a mega-drought.

Rojas says that Chile is "highly vulnerable" to further climate extremes. A 2011 government report found that the country, with its shrinking glaciers and water scarcity, met seven of the nine vulnerability criteria set by the United Nations Framework Convention on Climate Change.

For most of her career, Rojas has gathered data on the consequences of climate change in the region and analysed models of ancient climate shifts in the Southern Hemisphere. She was also one of the authors of a landmark report last year from the Intergovernmental Panel on Climate Change. With this new government, she says, "evidence is now reaching decision-making".

Rojas plans to prioritize climate action as head of Chile's environment ministry. One of her goals is for the country to enact its first framework law to achieve carbon neutrality by 2050. The legislation, approved on 9 March by Chile's Congress and awaiting Boric's signature, would regulate greenhouse-gas emissions, formulate adaptation plans and assign specific climate responsibilities to various sectors.

National programme

Another goal is to create a national programme, the Biodiversity and Protected Areas Service, which could also help to fight climate change by preserving "genes, species and ecosystems" in Chile (ecosystems such as forests absorb carbon emissions). A 2019 report from the UN-backed Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services estimated that, globally, conservation efforts such as these could provide 37% of the climate-change mitigation needed until 2030 to limit global temperature rise. Gathering conservation efforts under one national umbrella was the "missing piece" in Chile's environmental programmes, Rojas says.

"There is a very high level of expectation with this government," she adds. "I feel strongly committed not to disappoint — and to deliver a country that is on the path to greater well-being for Chileans."

Whether Boric and his administration will deliver on their proposals is yet to be seen. In the coming months and years, Sepúlveda says, scientists will be watching to see whether they keep their promises: "I hope, for the good of all Chileans, that this government does well."

REN HUI/VCG/GETTY

Scientists in China have had a chance to analyse Moon rocks for the first time.

CHINA'S FIRST MOON ROCKS IGNITE RESEARCH BONANZA

Samples collected by Chang'e-5 are providing exciting insights into the Moon's evolution.

By Smriti Mallapaty

Until recently, geochronologist Li Xian-Hua's research focused on molten rocks on Earth. But when a Chinese spacecraft delivered the country's first rocks from the Moon in December 2020, Li pivoted to study them. "I'm a new person working on extraterrestrial rocks," says Li, who is based at the Institute of Geology and Geophysics (IGG) at the Chinese Academy of Sciences in Beijing.

Li is one of many planetary scientists in China who have had the chance to study lunar rocks for the first time. The samples, collected by the Chang'e-5 spacecraft, are the first to be brought back to Earth since NASA's Apollo missions and the Soviet Union's Luna missions more than 40 years ago. They are being examined for clues to the Moon's evolution.

Those studies are starting to yield intriguing results. Some half a dozen papers have been published on the Chang'e-5 samples in the past six months. And earlier this month, at the Lunar and Planetary Science Conference in Houston, Texas, a session on China's lunar missions saw roughly a dozen studies presented.

"There are a lot of young Chinese researchers getting involved," says Clive Neal, a geoscientist at the University of Notre Dame in Indiana, who has worked on Chang'e-5 samples with collaborators in China. Several postgraduate researchers and students presented work on the lunar samples at the conference in Houston, he says. The rocks are exciting because they "represent a window into a very different era of lunar magmatism" compared with those gathered previously.

Youngest rocks

The Chang'e-5 mission recovered 1.7 kilograms of loose volcanic material called basalt from a vast lava plain, known as Oceanus Procellarum, in the Moon's northern region. The location was selected partly because it might contain younger volcanic material than the regions visited by the Luna and Apollo missions. The hope was that a younger site would give insight into a time when the Moon had started to cool but was still volcanically active.

Last July, the China National Space Administration released the first specimens to scientists across China. Some 17.5 grams of fine-grained powder and solid rock were distributed for 31 scientific projects selected from 85 applications. Several further rounds of applications to work with lunar samples have followed.

The first teams rushed to date the Moon rocks. On 7 October, one reported an age of 1.96 billion years (give or take 57 million years) for the basalts[1]. Less than two weeks later, another team, including Li, corroborated those dates, estimating the age to be two billion years (give or take four million years)[2].

The results confirmed that the Moon was still volcanically active almost one billion years after activity was thought to have peaked, according to analysis of the rocks from Apollo. But working out what fuelled this activity has proved tricky.

One leading theory, based on satellite observations, suggested that heat-producing radioactive elements such as potassium and thorium found in the lunar mantle might have driven the volcanism. But when another team at the IGG examined the lunar basalts, they determined that high levels of these elements[3] were not the source.

Another possibility was that the mantle contained enough water to reduce the temperature at which materials melt; this would have made it easier for the magma to erupt. But Lin Yangting, a planetary scientist at the IGG, and his colleagues found that the lunar rocks probably came from a relatively dry source[4].

Flummoxed

The question of the volcano's heat source has flummoxed scientists. "This is a very big science problem," says Weibiao Hsu, a planetary geochemist at Purple Mountain Observatory in Nanjing, China, because it reveals how much there is to learn about the Moon's evolution.

Hsu wonders whether a closer look at the basalts might reveal that they do actually come from a source rich in heat-producing elements, because the study by Lin and his colleagues was conducted on soil samples that contain many materials. Hsu has found that the rocks contain high levels of titanium, which suggests they came from deep in the mantle.

"We're exploring all possibilities," says Ming Tang, a geochemist at Peking University in Beijing, who received two tiny grains of basaltic rock and will analyse them to better understand the pressure and temperature in which they were created. The samples are a first for Tang, who previously studied magma from volcanoes on Earth. "It's a good opportunity for me and many other Chinese scientists interested in stretching their field," says Tang.

Hsu says there will be a lot of groups trying to solve the mystery. This year, his laboratory received more applications from students keen to join its graduate programme than it could accommodate. "This has never been the case before."

1. Che, X. *et al. Science* **374**, 887–890 (2021).
2. Li, Q.-L. *et al. Nature* **600**, 54–58 (2021).
3. Tian, H.-C. *et al. Nature* **600**, 59–63 (2021).
4. Hu, S. *et al. Nature* **600**, 49–53 (2021).

COVID'S TRUE DEATH TOLL: MUCH HIGHER THAN OFFICIAL FIGURES

Modelling suggests that by the end of 2021, some 18 million people had died because of the pandemic.

By David Adam

The number of people who have died because of the COVID-19 pandemic could be roughly three times higher than official figures suggest, according to a new analysis.

The study, published on 10 March, says that the true number of lives lost to the pandemic by 31 December 2021 was close to 18 million (COVID-19 Excess Mortality Collaborators *Lancet* https://doi.org/gpnw46; 2022). That far outstrips the 5.9 million deaths that the study says were reported to official sources for the same period. The difference is down to steep undercounts in official statistics, owing to delayed and incomplete reporting and a lack of data in dozens of countries.

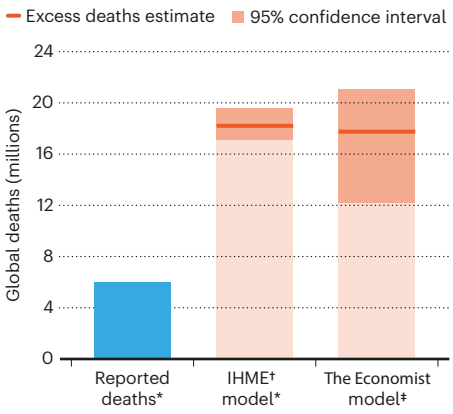
The loss of life "is much higher than simply assessed by reported COVID-19 deaths in most countries", says study co-author Haidong Wang, a demographer and population-health researcher at the Institute for Health Metrics and Evaluation (IHME) in Seattle, Washington.

The study uses a measure called excess mortality to overcome variation in the ways that countries identify and record deaths from SARS-CoV-2 infection. Researchers estimate excess mortality by comparing the total deaths reported in a region, from all causes, with how many deaths would be expected, given recent trends. Excess deaths are a good indicator of COVID-19 mortality, Wang says, citing studies from Sweden and the Netherlands suggesting that the disease caused most of the excess deaths during the pandemic. But he stresses that research is needed to separate deaths caused directly by COVID-19 from those that are indirect results of the pandemic.

The IHME team collected data on deaths from all causes in 74 countries and territories. For countries that do not produce such data, the authors used a statistical model to produce mortality estimates. The analysis indicates that between 1 January 2020 and 31 December 2021, reported deaths from COVID-19 totalled 5.9 million, but excess deaths might have totalled 18.2 million (see 'COVID's true toll').

COVID'S TRUE TOLL

The number of confirmed deaths (blue bar) caused by COVID-19 is much smaller than tallies of 'excess deaths' (pink bars), which are those above what is expected, during the pandemic.



*Up to 31 December 2021; †Institute for Health Metrics and Evaluation; ‡up to 27 December 2021.

Grim statistics

The IHME's figure for global excess deaths is the first to appear in a peer-reviewed journal. Its central estimate is similar to that of *The Economist* magazine in London (see go.nature.com/3d5bpc3), which arrived at some 18 million excess deaths by the end of 2021. But the error bars on the IHME's analysis are notably narrower: *The Economist* has a 95% uncertainty interval of 12.6 million–21.0 million; the IHME's is just 17.1 million–19.6 million.

Other researchers in the field have previously criticized the IHME's COVID-19 mortality estimates. Ariel Karlinsky, an economist at the Hebrew University of Jerusalem in Israel, says the new study's central estimate of 18 million is reasonable, but that some of the IHME's numbers for excess deaths in individual countries are significantly out of step with other sources. "They still have their ludicrous estimate for Japan at over 100,000 excess deaths, which is over six times the reported deaths," he says.

The IHME model contains some "bizarre features", adds Jonathan Wakefield, a statistician at the University of Washington in Seattle, who leads the World Health Organization's COVID-19 global death toll project. The IHME's approach leads him to doubt the validity of its uncertainty intervals and other statistical features of the modelling.

Different models and techniques will produce different results and uncertainty levels, Wang responds. For example, the IHME model uses 15 variables to estimate a country's excess deaths, whereas *The Economist*'s model employs more than 100.

THE ECONOMIST/INST. HEALTH METRICS EVAL.