



Hundreds of people were buried when the Wai Khar open mine collapsed on 2 July 2020.

POOR PLANNING MIGHT HAVE LED TO DEADLY MYANMAR MINE DISASTER

Study of Myanmar's worst mining accident suggests that human error contributed to 172 deaths.

By Andrew Silver

A detailed analysis of satellite and remote-sensing data has uncovered poor conditions at the Wai Khar jade mine in Myanmar, where a landslide last July killed more than 170 people.

The international team behind the study – the first to rigorously document a mining accident in Myanmar – says the results suggest that mismanagement and poor design contributed to the tragedy, which was not simply caused by monsoon rains, as was first assumed (Y. N. Lin *et al.* *ISPRS J. Photogramm. Remote Sens.* 177, 291–305; 2021).

As well as shedding light on the causes of the disaster, which have not yet been fully resolved, the findings are expected to aid documentation of mine collapses and improve site planning – both in Myanmar and in other countries that see frequent mining accidents.

Mining of jade for jewellery and carvings has exploded in Myanmar in recent years. About 400,000 miners scavenge jade from the slopes of open-pit mines, often with little safety equipment. They feed an industry that supplies 90% of the world's jade and earned an estimated US\$8 billion in 2011 – 20% of the

southeast Asian state's export revenue.

The jade industry in Myanmar is poorly regulated and mine collapses are common, causing many hundreds of deaths since 2004, according to the study authors. But a lack of transparency from the Myanmar authorities – together with political and ethnic conflict in northern Kachin state, where jade mining is centred – means field surveys of mine sites are “nearly impossible”, the authors argue.

Hundreds of deaths

Last June, in the run-up to what is thought to have been Myanmar's worst mining disaster, rain began to saturate the ground at the northern section of the Wai Khar open-pit jade mine in the region of Hpakant. Eventually, on 2 July, a huge volume of quarry slope materials “collapsed into a flooded open pit, burying and killing at least 172 jade miners”, write the authors.

Although mining companies in Hpakant had been ordered by the authorities to suspend operations from 1 July for three months for the monsoon season, impoverished freelance scavengers were still hunting for unpicked jade exposed by rain. Heavy rainfall was initially assumed to be the trigger for the collapse.

Myanmar's National Human Rights

Commission blamed the landslide on the lack of due diligence and risk assessment from mining companies – at least 12 of which owned licences covering specific parts of the Wai Khar mine at the time of the accident. But non-governmental organizations say that a lack of regulatory oversight from the government in the mining industry is also a major problem endangering the lives of miners in Myanmar.

A spokesperson for Myanmar Gems Enterprise – the government-owned regulator and issuer of mining licences – told *Nature* that mining operations at the Wai Khar open-pit mine ended on 29 June, before the accident, and that a government investigation had concluded that rainfall had infiltrated the ground through fractures in the rock, leading to the landslide. They added that the research findings will be valuable for assisting in future governance of the mining sector.

The mining companies could not be reached for comment on the study, or did not respond to *Nature's* queries on the disaster's causes.

Given the lack of access to mine sites in Myanmar, a team from Taiwan, Singapore, Brazil and Thailand used data from remote sensing and satellites to investigate the collapse. These are often used to monitor mine sites in nations that have strict mining regulations. “There are a lot of things we can do from space,” says study co-author Wang Yu, a geologist at National Taiwan University in Taipei.

Aggressive mining cycles

To look for deformation in the landscape around the Wai Khar mine over time, Wang and his team combined online video footage of the accident from the ground with aerial and satellite data, as well as historical data from a NASA space-shuttle mission in 2000.

The authors found two factors that they think triggered the collapse, in addition to rainfall. Firstly, the walls of the mine were dangerously steep given the weak nature of the rock surrounding the pit. Google Earth images

“The mining site is under aggressive mining cycles that are exacerbated by frequent, uncontrolled landslides.”

captured at intervals between 2013 and 2020 indicated periodic landslides had occurred in the pit, even where special steps had been dug out of the wall to prevent collapse, Wang says.

“The mining site is under aggressive mining cycles that are exacerbated by frequent, uncontrolled landslides,” he and his co-authors write. This process allows jade to be extracted more quickly, but creates dangerous conditions.

“The argument that the slope was too steep is very likely to be correct,” says Dave Petley, a geographer at the University of Sheffield,

ZAW MOEHTET/AFP VIA GETTY

UK, who studies landslides. He says he can't be sure the landslide was associated with mining practices, but operations should be designed to prevent deformation. "The authors show that the mine walls were actively deforming before failure," he adds.

Poor mine design

Secondly, the study authors say that piles of mine waste acted like a sponge for rainfall or groundwater, and probably gradually leaked water that eroded the walls of the pit, aiding its collapse. The waste piles, detected in digital elevation data from NASA's space shuttle in 2000 and Japan's Advanced Land Observing Satellite from 2006–11, shouldn't have been so close to the mine, they say.

In an e-mail to *Nature*, the authors say that "there are issues of mismanagement and bad design", but stop short of blaming anyone for the collapse. "Our analysis is only from the scientific viewpoint. It should be considered as an autopsy report, not a criminal complaint," they say. "A thorough investigation will be needed in order to determine the correct share of responsibility among different parties."

Kyi Htun, an independent mining geology consultant in Myanmar's capital, Yangon, says that after reading the study, he thinks that poor site management – such as not monitoring how the slope changed over time and not disposing of waste properly – probably played a part in the accident. "No one has done mine design properly" at the Wai Khar mine, he says.

Assisting other nations

San Htoi, a spokesperson for advocacy group Kachin Women's Association Thailand, who visited the mine after the landslide, says the findings are consistent with her observations: "The slope is too steep. It's so dangerous."

The authors of the study hope that the team's work will encourage other scientists to perform similar analyses in nations where mining is poorly regulated. Between 2004 and 2016, mine accidents led to deaths in 32 countries, according to one report (M. J. Froude and D. N. Petley *Nat. Hazards Earth Syst. Sci.* **18**, 2161–2181; 2018).

As for the latest study, "It is a very comprehensive analysis of the mining accident," says Birendra Bajracharya, coordinator of SERVIR-Hindu Kush Himalaya in Kathmandu, an international initiative that uses geospatial technologies to inform responses to environmental challenges. "The methodology will be useful to other researchers," he adds.

Study co-author Yunung Nina Lin, a geologist at Academia Sinica in Taipei, hopes that "the families of those who died can have a chance to learn about what had been happening on the mining site over the years", and that "those in power can take the messages from this research and transform them into real actions".

AFTER COVID, IS ONE VACCINE DOSE ENOUGH?

Previous coronavirus infection plus one dose of vaccine provides powerful protection – but concerns linger.

By Elie Dolgin

Many people who've been infected with the coronavirus might be able to safely skip the second jab of any two-dose vaccine regimen, a growing number of studies suggest. These results could help to stretch scarce vaccine supplies and are already influencing vaccination policies in some countries. But it's not clear whether the findings hold for all individuals and all vaccines – and therefore how policymakers should respond.

Studies show that people with previous exposure to SARS-CoV-2 tend to mount powerful immune responses to single shots, and gain little added benefit from another injection^{1–3}. In people with immunity gained through infection, one dose typically boosts antibody numbers to levels that are equal to, or often greater than, those found in individuals who have not been infected and have received two doses⁴.

France, Germany and Italy, among other countries, now advise only one dose of vaccine for people with a healthy immune system and a confirmed previous diagnosis. Many scientists who have studied immune responses to vaccination say such policies are a sensible way to make the most of limited supplies in countries that are racing to inoculate their populations.

"To follow the current two-dose vaccination schedule in previously infected individuals, when there are millions of people waiting for

their first dose, simply does not make sense," says Jordi Ochando, an immunologist at the Icahn School of Medicine at Mount Sinai in New York City, who has advised the Spanish government on vaccination guidelines.

But scientists still don't know whether one-jab programmes for previously infected people could leave some with suboptimal protection. Nor is it clear that such programmes would be effective for all types of vaccine.

"If you have been infected before, then probably one dose is sufficient," says Giuliana Magri, an immunologist at the Hospital del Mar Research Institute in Barcelona, Spain. But putting that knowledge into practice? "It's complicated," she concedes.

Just one jab

There's ample laboratory-based evidence that people who've been infected with SARS-CoV-2 benefit from vaccination, prompting the World Health Organization and other public-health agencies to recommend that such individuals still get vaccinated. There's less clarity, however, on whether they need to roll up their sleeves twice.

A paper⁵ published in *Nature* on 14 June provides some of the most recent evidence that one shot could be all that's necessary for people who've had COVID-19. A team of researchers at the Rockefeller University in New York City and elsewhere studied 26 people who had contracted the virus early in the course of the pandemic. All of them subsequently received at least one dose of either the Pfizer–BioNTech or the Moderna vaccine, both of which are based on messenger RNA.

The researchers analysed participants' levels of 'neutralizing' antibodies, potent immune molecules that can block the virus from entering cells. At the moment, the quantity and vigour of a person's neutralizing antibodies are the best markers for assessing whether that person is protected from infection and illness – although scientists are still working to confirm that antibody levels can serve as a realistic stand-in for immune protection.

The team also assessed participants' levels of memory B cells, which remember pathogens and can quickly crank out targeted antibodies if they encounter an infectious agent that they've seen before. Within a month or two of vaccination, study participants' levels



A worker prepares a COVID-19 vaccine.