CORBIS

Taming Africa's killer lake

An international team of scientists and engineers is in Cameroon to begin 'degassing' Lake Nyos, scene of a 1986 natural disaster in which a cloud of carbon dioxide killed more than 1,700 people. Tom Clarke assesses the risks and benefits.

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In one night, 1,700 people and many livestock were suffocated by CO_2 from Lake Nyos. A 1995 expedition has since tested degassing equipment.

When death came, it was silent and sudden. On the night of 21 August 1986, a cold and misty blanket of carbon dioxide gas flowed through the valleys that run down from Lake Nyos in northwest Cameroon. Hugging the ground, the dense, dank cloud suffocated livestock and smothered more than 1,700 people, many as they slept.

The region surrounding Lake Nyos is volcanic, and so sulphurous volcanic gases were initially suspected as the cause of the disaster. But subsequent investigations by teams of scientists dispatched to the remote highland lake suggested that as much as 80 million cubic metres of CO_2, formerly held in solution in the lake's depths, had been released explosively at its surface. Such an event, called a limnic eruption, had been recorded only once before — at nearby Lake Monoun, 35 kilometres from Lake Nyos. That eruption, which killed 37 people in 1984, was kept secret at first, as the Cameroonian authorities had suspected terrorist involvement.

Expeditions to Lake Nyos since the 1986 disaster have allowed researchers to unravel the geological processes that underlie the lake's lethal tendencies[1–3]. Armed with this information, a small group of scientists and engineers — funded to the tune of US$450,000 by the Office of US Foreign Disaster Assistance, with additional help from the French and Cameroonian governments — arrived in the area in January to attempt to 'degas' the lake, and so prevent it killing again. The plan is simple — the limited budget and the lack of decent roads into the region mean it has to be. The team will lower a length of high-density polyethylene pipe deep into the lake and pump CO_2-rich water towards the surface, where the gas can bubble out in a controlled way.

Most experts agree that degassing the lake is a good idea. But some say there is a small chance that the effort could trigger another limnic eruption and put lives at risk. Although villages surrounding Lake Nyos have been evacuated to avoid a repeat of the 1986 catastrophe, farmers and their livestock still venture into the area, lured by its lush pastures.

Under pressure

The water in Lake Nyos is divided into two layers. The surface layer, around 50 metres deep, is unremarkable, and is fed by rainfall and streams. But the lake's depths, which extend to around 200 metres, contain large quantities of dissolved CO_2. This became obvious when scientists began sampling the water after the 1986 eruption. "As we brought the samples to the surface the bottles exploded," says Sam Freeth, director of the Geological Hazards Research Unit at the University of Wales in Swansea, who visited the region two weeks after the disaster.

Further investigations revealed that the lake is fed from beneath by soda springs, which continually pump CO_2-rich water

into its depths. The pressure of the overlying water keeps the gas in solution. "It's like a bottle of champagne," says Alain Bernard, a geochemist at the Free University of Brussels. "Before you open it, you don't see any bubbles."

The thin boundary layer that separates the surface and deep waters is "like a membrane or barrier that's relatively strong and stable", says Bernard. But on 21 August 1986, this balance was disturbed, perhaps by a mudslide, rainfall, or unusual patterns of wind blowing across the lake — no one knows for sure. "Something stirred it up," says Freeth. The result was that water from the depths rushed to the surface and vast quantities of CO_2 came foaming out.

Since the eruption, CO_2 has been building up again. Based on estimates of how much gas was released in the disaster and measurements of the flow of CO_2 into the lake's depths, scientists think that, by 1992, the concentration of CO_2 had reached the same level as immediately before the 1986 event. Since then, the rise in CO_2 levels seems to have tailed off somewhat. "But everyone would agree the lake is as dangerous now as it was before the disaster," says Freeth.

Soda streams

Many of the scientists and engineers behind the current project visited the lake shortly after the disaster and have maintained a fascination with the problem of making it safe. Their long-term goal is to reverse the build-up of CO_2. As a start, they are assembling and deploying a 200-metre-long pipe, lowered from a platform in the middle of the lake (see diagram, right). If this test is successful, more pipes may be added later on.

As pumps draw water up the pipe, the CO_2 will begin to come out of solution. As it does so, the gas and water will start to rise up the pipe under their own buoyancy, sucking more water from the depths and creating a soda fountain that should become self-sustaining. The basic concept was suggested soon after the disaster[4–6] and was proven using a prototype during a previous expedition to Lake Nyos in 1995.

A second platform will also be floated on the lake, housing instruments to monitor the water's flow rate, its temperature, and the concentration of CO_2, which will be inferred from measurements of salinity and electrical conductivity. The instruments will allow the team to see how successful the fountain is in removing CO_2 from the lake. "We hope that it will be sufficient to lower the levels," says Bernard.

Constant monitoring will also be important for safety reasons. The expedition team intends to stay at the lake until 8 February, after which a satellite link will relay data back to the laboratory of one of the project's leaders, Michel Halbwachs at Savoie University in Chambery, France.

Although the principle of degassing has been proven, there is still a lot to learn about how best to operate such a scheme. The researchers have opted for just one pipe in the first instance, because they are concerned that more might destabilize the lake. "The outcome of this experiment is not to empty the lake of CO_2 but to measure the influence that one pipe has on the stratification of the lake," says Jean-Christophe Sabroux, an engineer with France's Atomic Energy Commission. If it looks as if the degassing is in danger of getting out of control, the pipe is fitted with a valve that can be closed off remotely. The decision on whether to shut it will lie with Cameroonian officials. "They are the ones who will ultimately be affected," says Sabroux.

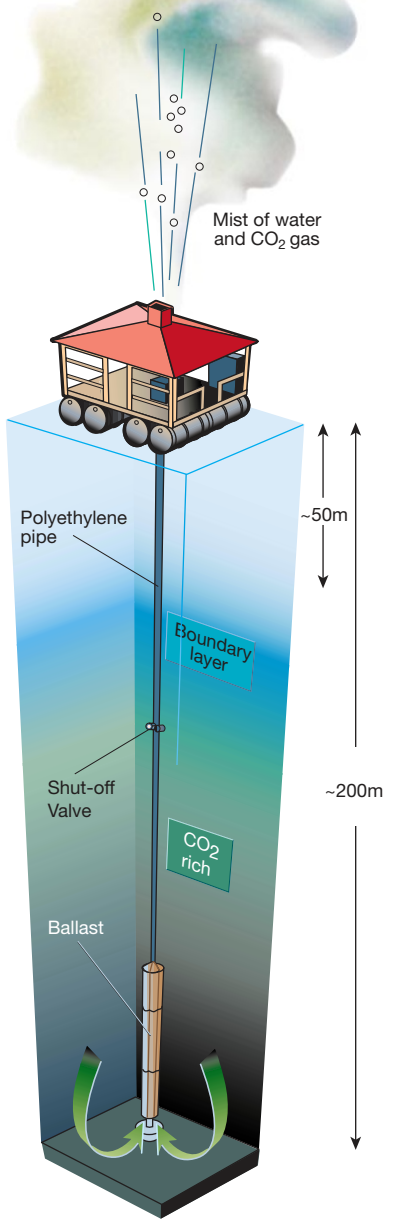
Lakeside manners

Despite these measures, Freeth, who is not involved in the present project, remains worried about the risks. "There's a lot of gas in that lake and I'm concerned that sticking pipes in and bringing up water could destabilize the lake," he says. Freeth fears that CO_2-rich water spouting from the pipe and landing on the lake's surface could sink back down and disturb the boundary layer.

Sabroux plays down the dangers. Calculations made during previous visits to the lake, including the 1995 trial run, suggest that Freeth's concerns are unfounded, he says. By starting cautiously with a single pipe and monitoring it closely, Sabroux says, the team will learn how to handle the killer lake. He argues that scientists cannot simply stand by and let Lake Nyos continue to pose a hazard. "Everyone connected with the project knows they are taking risks, but they are worth facing," he says.

Sabroux adds that there are sufficient safety procedures to protect the expedition team and local people helping with the project. Roads into the area will be closed and a system of CO_2-monitoring stations with alarms has been installed around Lakes Nyos and Monoun. If the alarms sound, all personnel working at Lake Nyos have been instructed to head to areas of high ground where, because CO_2 is more dense than air and tends to hug low ground, they will be safe. Those working on the lake itself have been equipped with breathing apparatus provided by the Cameroonian military.

Even if the degassing project proves a resounding success, the danger posed by Lake Nyos may not be over. One section of the shore, where a waterfall drains the lake during the wet season, is a natural dam made up of loosely packed volcanic rock. The wall of the dam is already heavily eroded[7], and geologists who have studied the site are concerned that it could collapse. "Perhaps in the not so far distant future, that dam could fail," says Freeth.



Gas station: the 200-metre pipe should allow CO_2 to be extracted from Lake Nyos safely.

If so, according to some predictions, the upper 40 metres of water in the lake could flow down valleys to the north, causing flash floods in heavily populated regions of Nigeria some 150 kilometres away. And if that were to happen before the lake is degassed, it would also almost certainly cause an encore of the 1986 eruption. ■

Tom Clarke is a science writer based in London.

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