live," says Jenni Barclay, a volcanologist at the University of East Anglia in Norwich, UK. Volcanic soil is often fertile and the altitude provides good living conditions in hotter climates.

Worldwide, 62 volcanoes fell into the highest risk category, meaning that they have been recently active and lie close to a lot of people. Indonesia tops the list of most threatened countries, with 77 historically active volcanoes, including Mount Merapi, which erupts frequently near the city of Yogyakarta.

But by a different measure, small volcanic islands — such as Montserrat in the Caribbean — are the most vulnerable. When these island nations start to rumble, all their citizens must flee or risk death. In these places, uncertainty has its cost: a controversial 1976 evacuation of the Caribbean island of Guadeloupe left residents angry when no major eruption happened.

Just because a volcano ranks as hazardous does not mean that people living near it are sitting ducks. If a volcano has enough scientific monitoring equipment on it, and a well-organized local response, then the risk to human life can be reduced, says Stephen Sparks, a volcanologist at the University of Bristol, UK, and a lead author of the report. At Merapi in 2010, the authorities used information about physical changes in the volcano to evacuate hundreds of thousands of people before a large eruption, saving many lives.

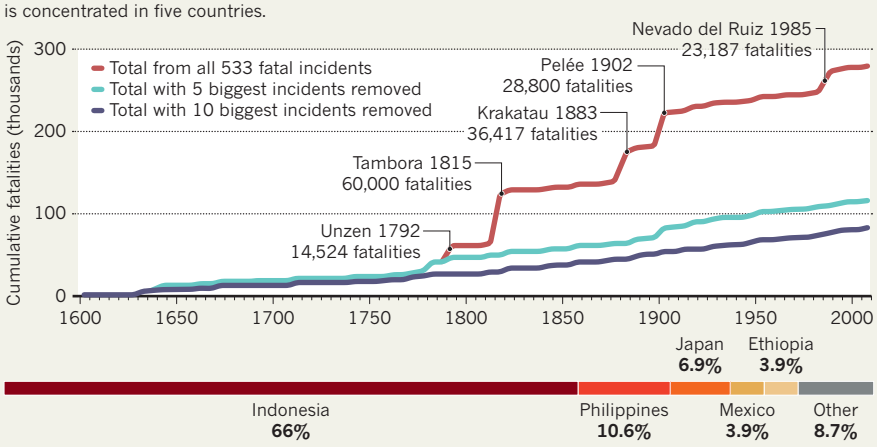
"We want to showcase what volcanologists around the world are doing," says Sue Loughlin, a volcanologist at the British Geological Survey in Edinburgh and another leader of the survey.

In Ecuador, around the Tungurahua volcano, local volunteers serve as a network of *vigías* or 'volcano watchers'. They watch for changes in the mountain and radio in to the nearby volcano observatory every evening with their reports (J. Stone *et al. J. Appl. Volcanol.* **3,** 11; 2014). Such initiatives could translate to other volcanically active regions, says Barclay. "We can learn much more by bringing all this knowledge together." ■

SOURCE: GLOBAL VOLCANIC MODEL/IAVCEI

MASS DESTRUCTION

More than half of the fatalities caused by volcanic eruptions in the past four centuries occurred in just five major events that killed an estimated 162,928 people. Today, more than 90% of the volcanic risk is concentrated in five countries.



BIOTECHNOLOGY

Therapeutic cancer vaccine survives biotech bust

Pharmaceutical company rescues landmark prostate-cancer treatment, Provenge.

BY HEIDI LEDFORD

The first therapeutic cancer vaccine to be approved in the United States will stay on the market despite the financial collapse of the trailblazing biotechnology company that developed it. The vaccine, Provenge (sipuleucel-T), was purchased on 23 February by Valeant Pharmaceuticals of Laval, Canada, which paid US$415 million for the prostate-cancer treatment and other assets of the bankrupt Dendreon Corporation.

The now-defunct Dendreon, of Seattle, Washington, made history in 2010 by showing that complex treatments made fresh for each patient could win regulatory approval, and could be expanded beyond the realm of specialized academic hospitals. Industry took note: today, experimental cancer therapies that spur patients' immune cells to attack tumours are among the hottest properties in biotechnology.

"Dendreon had vision and foresight," says Usman Azam, head of cell and gene therapies at Novartis, a Swiss pharmaceutical company that has purchased one of Dendreon's manufacturing plants to fuel its own cell-therapy efforts. "Don't view Dendreon as a failure: it paved the way."

But although Dendreon created the market for such cell therapies, it ultimately could not survive in it.

Provenge is made by harvesting a patient's dendritic cells — a type of immune cell — and then mixing them with a protein that is particularly abundant in prostate tumours. This primes them to recognize and attack the tumour; the cells are then infused back into the patient.

The technique was pioneered in the early 1990s by Edgar Engleman, an immunologist at Stanford University in California, who had seen promising results in animal studies of a different cancer, lymphoma. He teamed up with fellow Stanford immunologist Samuel Strober to work out ways to make the process more efficient.

When the two pitched their idea for a company to investors, they had few clinical data and were too optimistic about how fast the treatment could reach patients, says Strober. The company was an enormous gamble: harnessing the immune system to fight cancer was still a controversial idea, and no other company had marketed a therapy so personalized and labour-intensive. "But at that time it was a little different from now," says Strober. "Companies were getting funded on the basis of promise, rather than actually looking at their capacity for early commercial success."

Engleman and Strober founded Dendreon in 1992; the US Food and Drug Administration approved Provenge in 2010.

The approval was celebrated as an important proof of concept by researchers working on cancer vaccines and other treatments that stimulate immune responses to the disease. But Dendreon, already strained by the long wait for approval, soon ran into financial difficulty. ▶

The United States' publicly funded Medicare system decided in 2011 to pay for Provenge treatment. But confusion over how the cost of the vaccine would be reimbursed by private insurance companies left many US doctors hesitant to use it, says Corey Davis, an analyst at Canaccord Genuity, an investment bank based in Toronto, Canada. When revenues came in far below the company's initial estimates, Dendreon failed to adjust its operations accordingly, Valeant chief Michael Pearson told investors on 23 February.

Provenge is, at first glance, an odd purchase for Valeant, a company known for acquiring relatively simple, established products — for example, it controls 10% of the US contact-lens market. But Valeant saw an opportunity to cut costs and improve how the vaccine is marketed to doctors, and thinks it can make back its investment in less than two years, says Davis.

The vaccine's rescue is a relief to Engleman, who had feared that Provenge might disappear along with Dendreon. As the company struggled financially, the scientists who founded it watched helplessly from the sidelines. "This was our baby," says Engleman. "It was extraordinarily frustrating. There was nothing we could do."

In retrospect, Engleman says, some early scientific choices may have exacerbated Dendreon's struggle. He notes that the company decided not to develop ways to freeze the stimulated immune cells, which could have simplified the procedure and lowered its cost.

"Don't view Dendreon as a failure: it paved the way."

Both scientists lament the choice of prostate cancer as the inaugural disease target of the technology. Although the early lymphoma data had been very promising, recalls Engleman, the company decided to switch to a more common cancer with a bigger potential market. And prostate cancer had another advantage: people can live without a prostate, which helped to calm fears (since proved unfounded) about what would happen if the primed immune cells attacked healthy tissue.

But the results in prostate cancer were not as dazzling as Engleman had hoped on the basis of his animal results in lymphoma. Dendreon did extend survival in some people with advanced prostate cancer, but by a median of only four months (P. W. Kantoff *et al. N. Engl. J. Med.* **363,** 411–422; 2010). Last week, the UK National Institute for Health and Care Excellence advised that at more than £47,000 (US$73,000) per course of treatment, Provenge is too expensive to justify its use by the National Health Service.

The Dendreon experience has not dampened Engleman's enthusiasm for entrepreneurship. He and Strober, along with other collaborators, have teamed up on a company that aims to develop a technique to reduce the likelihood that recipients of transplanted organs will develop an immune response to the new tissue.

They are again on the hunt for funding, but this time the team is backed by more than a decade of clinical-trial data that supports the method. "We're thinking that this one will progress a lot faster than the Dendreon thing," says Strober. ■

HYDROLOGY

Slick idea proposed to stretch water supplies

Thin coating that cuts evaporation from lakes offers hope for drought-ridden United States.

BY MATTHEW WALD

In the southwestern United States, where years of drought are leading water managers to consider drastic water-provision measures such as desalination and cloud seeding, entrepreneurs have suggested reviving a technique that was tried and abandoned half a century ago. They propose to stretch dwindling water supplies by slowing down evaporation from reservoirs by means of a surface barrier of cheap, non-toxic, biodegradable chemicals just one molecule thick — two-millionths of a millimetre. The technology is far from proven, but it showed some potential in field tests in Texas last year.

Worldwide, more water evaporates from reservoirs than is consumed, and the losses are especially acute in hot, dry regions. The idea of a coating to slow evaporation has been floated for decades, and government researchers in the United States and Australia have investigated the concept. The approach, which generally involves chemicals derived from coconut or palm oil, is already used on small bodies of water such as golf-course ponds and swimming pools. But it has not been practical for larger bodies because wind tends to break the layer apart, says Moshe Alamaro, an engineer at the Massachusetts Institute of Technology in Cambridge.

Last summer, a field test in Texas attempted to overcome that problem. The US$325,000 test ran from July to October on Lake Arrowhead, a 21-square-kilometre reservoir that serves the city of Wichita Falls. Flexible Solutions International, a company in Victoria, Canada, that makes evaporation-reducing coatings for small water bodies, programmed a boat to run on autopilot and make a grid pattern across Lake Arrowhead spreading the coating behind it.

An analysis published in January by the Texas

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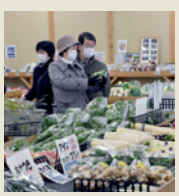

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