'Great Green Wall' dampens Gobi dust storms

The ancient Chinese emperors built the Great Wall, ostensibly to defend against Mongol forces from the north. When Mao Tse-tung took over China, he continued that tradition, with a green twist. Since the 1950s, the world's most populous nation has planted 300 million trees along the path of the Great Wall to keep out invading dust storms from the Gobi Desert and other arid regions.

The ancient stone and earthen barrier worked only marginally well as a defensive measure. But the green version has succeeded, according to a team of U.S. and Chinese researchers. In the June 1 GEOPHYSICAL RESEARCH LETTERS, the group reports that the frequency and duration of dust storms have dropped over the last four decades at several monitoring stations in China.

At a time when several nations are contemplating planting millions of hectares of trees to offset global warming, the Chinese effort demonstrates that afforestation can alter regional climate.

"Vast belts of forest planted across the northern arid lands of China, called 'The Great Green Wall,' are probably one of the most aggressive weather modification programs in the 20th century," according to atmospheric chemist Farn Parungo of the National Oceanic and Atmospheric Administration in Boulder, Colo., and her colleagues.

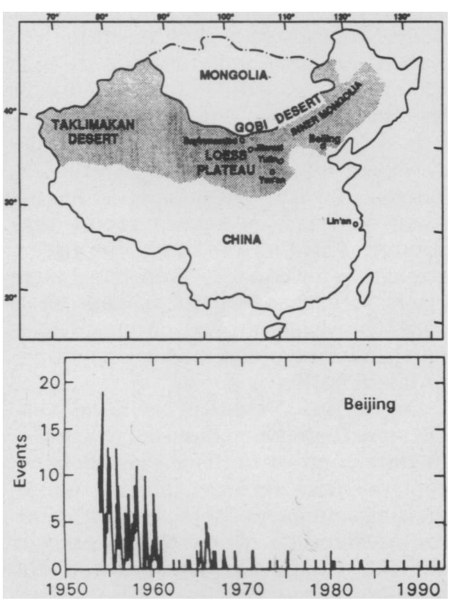
The team of researchers analyzed weather data reaching back to 1955 for Beijing and two cities to the west. Chinese meteorologists define a dust storm as any time that wind-blown dust reduces visibility to less than 1 kilometer.

During the 1950s, 10 to 20 dust storms blew through Beijing each spring, blotting out the sky for 30 to 90 hours per month. By the 1970s, fewer than five storms hit each spring, and their duration dropped to less than 10 hours per month. Fine-grained silt continues to sweep through Beijing each spring, at times quite noticeably. But it rarely reaches the meteorological definition of a dust storm, Parungo says.

Belts of trees reduce dust principally by slowing winds and preserving soil moisture. Cities and villages typically plant swathes of fast-growing trees, with land in between left for cultivation.

Kenneth Andrasko, a forestry researcher with the U.S. Environmental Protection Agency in Washington, D.C., says China may have the largest tree-planting program in the world. Yet he wonders whether other factors helped reduce the frequency of dust storms: Advances in farming techniques, changes in livestock distribution, or subtle climate shifts might also have played a role.

Parungo and her colleagues suggest that the Green Wall could have effects that reach far beyond China's borders. The dust storms transport silt across the Pacific, even as far away as Hawaii and Alaska, dumping minerals and nutrients into the ocean. Dust also stimulates the growth of clouds and enhances precipitation. *— R. Monastersky*



Parungo/GEOPHYSICAL RESEARCH LETTERS

China has planted trees in parts of the shaded region to prevent dust storms. Graph shows monthly frequency of storms in Beijing.

Last word not yet in on Fermat's conjecture

Last June, mathematician Andrew Wiles of Princeton University stunned the mathematical community and drew worldwide attention when he dramatically announced a proof of Fermat's last theorem. A year later, the arguments presented by Wiles stand as a considerable mathematical achievement, but a troublesome gap in his lengthy chain of reasoning leaves Fermat's last theorem unproved.

"It took people a while to realize how serious the problem was," says Kenneth A. Ribet of the University of California, Berkeley. "And it has not yet been taken care of."

Fermat's last theorem asserts that for any whole number n greater than 2, the equation $x^n + y^n = z^n$ has no solution for which x, y, and z are all whole numbers greater than zero. A proof of this assertion's validity has eluded mathematicians for more than 350 years.

In his approach, Wiles followed up several key discoveries made by other mathematicians during the 1980s. These insights linked Fermat's last theorem to important ideas in number theory, particularly to mathematical entities known as elliptic curves (SN: 6/20/87, p.397).

Wiles took advantage of these connections in his announced proof of certain cases of the so-called Taniyama-Shimura conjecture, which in turn establishes the truth of Fermat's last theorem. He outlined his reasoning in three lectures last June at the University of Cambridge in England (SN: 7/3/93, p.5).

"His overall strategy looked wonderful," Ribet notes.

Wiles then submitted a preliminary, 200-page manuscript of the proof to the journal INVENTIONES MATHEMATICAE. In turn, copies of the manuscript were sent out to about half a dozen mathematicians for checking, but no copies were circulated publicly. Wiles himself continued to work quietly on his proof, clarifying arguments and correcting problems pointed out by the referees.

Late last year, Wiles broke his silence and sent out an electronic-mail message acknowledging a gap in what he had thought was an airtight proof (SN: 12/18&25/93, p.406). The problem involved calculating a precise upper limit on the size of a mathematical object called the Selmer group. Without confirming that this group is small, the proof remained incomplete.

Disappointed but intent on continuing, Wiles said at the time, "I believe that I will be able to finish this in the near future using the ideas explained in my Cambridge lectures."

Starting in February, Wiles gave a detailed account of his work in a course he was teaching at Princeton, covering parts of the proof that had already been checked and verified. Meanwhile, he refined the first few chapters of his lengthy manuscript into a form suitable for circulation.

Wiles also expended a great deal of effort thinking about the obstacle lying in his path toward Fermat's last theorem. In a rare public lecture, which took place last month at the Institute for Advanced Study in Princeton, N.J., a relaxed Wiles explained that he now believes the difficulty is probably surmountable — that he understands the problem well enough to see its connection with something more standard in mathematics.

"I think his intuition is that he's very close and that no new ideas are needed," says Peter C. Sarnak, one of Wiles' Princeton colleagues. "But you never know with something that looks standard. There may be some subtle issue here which makes it nonstandard."

Wiles will continue his lecture course at Princeton this fall, when he will at last reach the point in the proof where his difficulty lies. He may have an answer by then or he may not.

As mathematicians begin to understand the details of what Wiles has accomplished, it's possible that someone else may find a way to bridge the gap

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