Why ancient canals went wrong

The intricate, mammoth canal system that slashed through the coastal desert of ancient Peru failed not because of faulty engineering, scientists report, but because movement of crustal plates gradually distorted the landscape.

In a report to the National Science Foundation, which funded the research, Michael E. Moseley of Chicago's Field Museum of Natural History and Charles Ortloff, an engineer with General Electric's Nuclear Division in San Jose, Calif., describe the irrigation systems of the Chimu, a populous tribe once powerful on the Andean coast of what is now northern Peru. The Chimu flourished until the Incas invaded in 1476. Between A.D. 500 and A.D. 1200 the tribe built the largest irrigation network ever constructed in South America, employing engineering techniques impressive even by modern standards.

Since then, cultivated land in that region has retracted to one-third to one-half of the area used 1,000 to 2,000 years ago, Ortloff says. "We wondered why. Progress of *most* civilizations is upward, toward more land in use, more technology devoted to the development of resources." When the scientists investigated the reasons for the decline, they found that vertical oscillations of the landscape in the study area average 1.8 centimeters per year — more than enough to disrupt the delicate equilibrium of the slope-sensitive canals.

Field Museum of Natural History, Chicago

Erosion by torrential rains exposed an earlier channel buried beneath the visible one in northern Peru. The canal system's architects, the Chimu tribe, were forced to rebuild the canals after tectonically induced uplift changed the ground-slope, making the canals inoperable.

Ortloff says the Chimu tried to redesign some canals to counter the effects of seismic and tectonic activity, but the forces were too strong for them to overcome. "If the coastline suddenly shifts at an angle, the rivers incise more and strand inlets that had been built for a particular canal," he says. The problems were compounded when the periodic tropical storms called El Niños unleashed their torrential rains on the arid land. The ensuing flash floods would have inflicted inestimable damage to canal systems already out of equilibrium. Legends and the sedimentary record tell of a "mega" El Niño that occurred about A.D. 1100, destroying the canal system in the Moche Valley.

Moseley says his main interest is to understand long-term historical development of a civilization in terms of a very dynamic landscape. However, the findings pertain to modern events as well: A giant irrigation system currently under construction in Peru eventually will face the same geophysical threat as its ancient counterpart, scientists predict. "This is one of the rare cases where archaeologists can do something in the applied sense," says James Richardson, a curator at the Carnegie Museum in Pittsburgh: Relatively little is understood of the geology in northern Peru over the last 10,000 to 12,000 years, he adds. "It makes us feel an urgency for doing the work, to work out the total record of these natural catastrophes, and to try to learn how they affected populations." —*C. Simon*

Who benefits in reform of wetlands laws

The I. Doan Kare Development Co. has plans to build a shopping mall atop a marsh adjacent to Fishing Galore, a 100-acre lake in Wisconsin. To develop the property, the wet marsh will have to be dried. And I. Doan Kare made quite a deal with a local pharmaceutical manufacturer to inexpensively purchase chemically contaminated sand as filler for the marsh. True, by converting the marsh into a shopping mall, several rare cranes and herons will be evicted. And there is some concern that the sand might contaminate sport fishing in the lake. But the developers say it will pump money and jobs into an economically starved resort community.

Of course this hypothetical story is an environmentalists' nightmare. But changes enacted July 22 in section 404 of the Clean Water Act regulations administered by the Army Corps of Engineers (ACE) will make such nightmares possible, if the marsh in question sits above the headwaters of a regulated waterway.

Until this past week, the developer in question would have had to get a permit to modify wetlands like this marsh, and the permit would only pass U.S. Fish and Wildlife Service scrutiny if it were deemed to pose "minimal environmental impacts." But such developers no longer need permits for these sites owing to one of several new and revised nationwide general interim final rules promulgated by ACE. Large lakes with diverse ecosystems and their surrounding wetlands may pay a high price, but William Gianelli, Assistant Secretary of the Army for Civil Works, notes that such changes will streamline the ACE regulatory workload.

William Y. Brown, senior scientist in the Environmental Defense Fund's wildlife program, considers the change to ACE's headwaters nationwide rule "the very worst" of the proposed section 404 permitting rules advocated by Gianelli. And that's why Brown is working hard to see it modified in the comment period that just began.

Wetlands are characterized by soil saturated with water and ecosystems adapted to life where the ground is saturated. Of the 75 million acres of them left in the continental United States, roughly 330,000 are lost each year. Yet they are critical not only to the survival of fish and wildlife, but also to recharging and filtering ground water and to flood control. —*J. Raloff*

1979 CO_2 report reaffirmed

The National Research Council's Carbon Dioxide/Climate Review panel has reassessed an NRC report made in 1979 and finds that, even in light of the abundant research conducted in the interim, the conclusions of the earlier report do not require "substantial revision." The NRC panel reaffirms the earlier prediction that when CO_2 concentrations eventually double (mainly due to combustion of fossil fuels) the global surface temperature will increase nearly "3°C with a probable error of ±1.5°C." The warming would result because the CO_2 insulates the earth, absorbing energy the planet normally would radiate back into space. Regardless of when the increase occurs, climate patterns almost certainly will change, with temperature increases varying with season and latitude. The thickness and extent of Arctic and Antarctic sea ice probably will decrease. The panel encourages observations of the thermal response of the oceans to increasing CO_2, and also refutes two recent studies predicting that increased CO_2 will cause far lower temperature changes. □