Science, the Public and the American Drought

John Wesley Powell, the explorer of the Colorado River, pioneer geologist, and brilliant organizer of early efforts for the scientific study of the American West, spent considerable energy during the 1870s trying to educate the westward-shifting American populace to the hazards of settling in the arid and semiarid lands of the West. Drought will come in cycles, he warned, and years of plenty will inevitably be followed by years of poverty.

Since then four droughts have visited their wrath upon the land. Now another has hit, and some scientists are warning that this one could become as serious as the disastrous dust-bowl years of the 1930s.

Public leaders in the West are laying plans to prepare for the disaster, climatologists are trying to forecast its intensity, agricultural scientists are working on technological options, and political and social scientists are trying to anticipate the consequences. And the echo of Powell is being heard in calls to restrict the further growth of population in areas of uncertain water supply.

All this came to a focus this week at the annual meeting of the American Association for the Advancement of Science in Denver, while the Rocky Mountains just to the west, normally snow-packed in February, basked barely—and ominously—in near-summertime warmth. This year's AAAS meeting, past chairman Margaret Mead noted, was being held "in a distinctive area of the United States with distinctive problems," and the AAAS had "made a special effort to relate this meeting to this region."

The problem on everyone's mind was the impending drought. Just the day before, 11 western governors meeting in Denver voted unanimously to create a task force to prepare for it. Five continuous days of sessions on arid lands were scheduled at the AAAS meeting, and a kickoff session on American droughts brought crowds that overflowed onto the floor and out into the hallways. Like the record-cold winter in the East, the drought in the West has suddenly grabbed the public consciousness. The message heard was not encouraging.

"The United States is experiencing the most severe drought problem of anywhere in the world at the present time," declared Richard E. Felch of the National Oceanic and Atmospheric Administration in Washington. "It is too early to say whether it will be as bad as the 1930s, but the possibility does exist. The stage is set."

A rating of drought conditions known as the Palmer Index shows a drought pattern at the present moment disturbingly like that of 1934, one of the worst years of the 1930s, he says. One can never say these things with any degree of certainty, he cautions, but "If it continues dry for another 60 days, it could become as bad as the 1930s." And the next 30 days is particularly crucial for Colorado and Kansas, he warns. It would take a most unusually wet spring to get the region out of trouble, says Norman J. Rosenberg of the University of Nebraska.

USDA

Lots of wrath, few grapes. This was Colesville, Colorado in 1930. Does this year's drought portend another dustbowl?

The drought, says L. Dean Bark of Kansas State University, comes at a time when the nation is more vulnerable to drought than during earlier episodes, due to the shift of population to the southwest and California in recent decades. Bark points to a detailed 750-year chronology of drought cycles in the West, amassed in large part by tree-ring research at the University of Arizona, as a reminder that the problem is recurring and inevitable.

"The crime," says Walter Orr Roberts, an atmospheric scientist who has long been warning of the drought possibility, "is not to recognize that recurring drought is part of the norm."

The social, political and cultural impacts of the drought concern Robert D. Miewald, a University of Nebraska political scientist. He fears that in Nebraska, "The stirrings of concern will be swept away by the first rainstorm" and that even afterwards, "when the next drought comes—whenever that is—the problem still will not have been solved."

If people continue to treat it as just another temporary, bad event that will go away soon, nothing will be gained, Miewald says. He hopes for the emergence of a new perception of reality, one that will lead the public to deal with the fundamental social issues. In northern California's Marin county, perhaps the hardest hit of all areas so far, "is the real question too little water—or too many people?" Miewald asks.

J. Eugene Haas, a University of Colorado sociologist, points to the example of Hawaii. There a serious state effort is underway to declare Hawaii, as a unique area of the United States, a "national treasure" and to decide by going up through the court system whether it would be legal for Hawaii to restrict its population.

The same question, says Haas, applies to the continental United States: "Should heroic measures be taken every time the water supply becomes too short? Or should efforts be made to bring the size of the population and the supply of water into some kind of reasonable balance?"

Haas's analysis of the effects of adoption of various drought-mitigation activities have produced some profound and surprising conclusions: Certain activities, such as drought-relief aid, have negative long-term effects, by encouraging farming on drought-prone land. Even irrigation's net long-range effect is neither positive nor negative. The only two practices that both increase net social benefits and reduce catastrophe potential are improved weather prediction and forecasting and—most effective of all—land-use regulation. The latter involves restrictions on population growth, clearly an issue of explosive potential.

Not all the news is glum. Nebraska's Rosenberg describes numerous experimental advances in making crops and the land less vulnerable to drought. The value of trees as windbreaks has long been known, but now it has been shown that vegetative windbreaks—wheat grass, for example—can induce a microclimate beneficial to both the shelter grass and the sheltered crop. The use of corn as a windbreak for sugar beets can produce a 16 percent increase in sugar beet yield. The leaf architecture of soybeans can be

altered to make crinkled leaves that hold water. And the ability of plants to reflect sunlight can be bolstered biophysically so that less water is lost through evapotranspiration. Rosenberg says he is confident that such technologies can have major impact—over a period of time—in lessening drought's effects.

All seem agreed that the social sciences, the physical sciences and the agricultural sciences all have crucial roles to play. And, concludes Rosenberg, "We need a national strategy to cope with drought." □

Pueblo population explosion

One of the most consistently popular features of each AAAS meeting is the annual public lecture sponsored by the National Geographic Society, which this year adhered to the meeting's regional theme by presenting a film of the first modern excavation of a 14th-century Pueblo in the Rio Grande area. The film was narrated by Douglas W. Schwartz, director of the School of American Research in Santa Fe, who conducted the excavation.

In an interview with SCIENCE NEWS, Schwartz called the northern Rio Grande region near Santa Fe "the stepchild of southwest archaeology." People settling there, he says, were the "country cousins" to Indians in larger, better-known pueblos farther west, like Mesa Verde. Yet, for all the Indians in the area, the 14th century was a critical period, with Mesa Verde being abandoned just as a recently excavated site—Arroyo Hondo, 5 miles south of Santa Fe—was experiencing a population explosion.

After carefully applying four dating techniques, Schwartz concludes that the original village at the site grew from only three families in 1285 to more than 1,000 people 30 years later. "For a primitive population," he says, "that is an amazing increase." The Pueblo eventually grew into a large complex of apartments with three to five rooms each and at its peak in about 1330 would have housed perhaps 1,700 people.

But again the population changed rapidly. By 1350, the site had been completely abandoned; 20 years later it again had a substantial population of 400; and by 1420 it had been permanently abandoned. These changes, Schwartz says, "seem to correlate exactly with the climate changes we see."

The critical factor was water, whose availability can be measured quite accurately by studying tree rings from the time. As water decreased, food became scarce and the very young were the first to suffer. Eventually half the children were dying before they reached the age of five from causes related to malnutrition. Abandonment of the site, Schwartz says, was thus not so much a matter of mass migration as a "fading away," as the population eventually dwindled down to a few old timers. Schwartz hopes to incorporate the knowledge learned at this excavation into a more general model of population explosions.

The film, produced by the National Geographic Society, illustrates four years of the painstaking work needed to draw such conclusions. (The work itself was funded by the National Science Foundation.) In one sequence of time-lapsed photography, the eight days required to excavate a single room is compressed into two minutes, giving the viewer a new appreciation for archaeology as both the most strenuous and most tedious of sciences.

The interdisciplinary nature of the modern archaeological dig is also illustrated. A paleobotanist pieced together clues to the Indians' varied diet. An ecologist tested soil in the area to determine where fields had been and then replanted the crops and raised them. In an experimental dating method magnetic fields frozen into the ashes of ancient fires were correlated with records of the wanderings of the magnetic North Pole.

Schwartz is reluctant to apply the lessons of Arroyo Hondo to the modern population explosion or to threatening changes in climate that some other scientists have said could devastate vulnerable societies. He points out the obvious difficulty of extrapolating from a simple society to a complex one. But then he pauses and begins to talk of the "delicate balance" of nature in drought-stricken northern California. The shrinking of previous societies in response to climate is unmistakable, he says. And then "maybe we will see a contracting in our own day." □

Double challenge of western coal

Reports on studies sponsored by the Council on Environmental Quality and the Environmental Protection Agency indicate that the economic incentives for tapping the vast coal resources in the western United States would be almost irresistible, but that environmental penalties would also certainly be severe. One ray of hope for a "technological fix" comes from an upbeat report of progress in underground coal gasification. The conclusions were reported at the series of symposiums on regional themes at the AAAS meeting this week in Denver.

The CEQ study, by Joyce M. Kelly, presents results of various possible scenarios of development, highlighting the strengths and weaknesses of each. The assumption is that coal mined, say, in Montana, will eventually produce electricity used in some larger city far to the east, for example, Chicago. The electricity could be generated at the mouth of the mine, or coal could be hauled by rail to Chicago or it could be mixed with water and sent as a slurry. Or the coal could be gasified before burning—at the mine in Chicago, or at some intermediate point.

Gasification produces only about 10 percent as much air pollution from sulfur oxides as direct burning, but the process requires more water and more land. Transportation by rail or slurry is efficient, but rail transport generates additional air pollution, while slurrying would require great quantities of water in a region where it is scarce. Producing electricity at the mine mouth and carrying it by wire to Chicago would waste four or five times as much energy as rail or slurry. The question of water availability for some schemes has not yet been solved, and environmentally, "none of the scenarios seem to be clearly preferable."

In considering direct costs, however, there is no contest. "Generating electricity directly from coal at Chicago involves the least dollar cost and . . . it is always less expensive to generate the electricity directly from the coal than to gasify it first."

The EPA-sponsored study was conducted by a team from the University of Oklahoma and from the Radian Corp. Oklahoma zoologist Irvin L. White prepared the report. This study did address the problem of water availability and water pollution, concluding, "Water problems and issues are clearly the single most significant category of problems and issues that policymakers will have to deal with in choosing among energy development alternatives."

Some, though by no means all, of the problems discussed could be eased by gasifying coal while it is still underground. The idea is actually quite an old one—dating back to 1848—and the Soviet Union has been experimenting with *in-situ* gasification since 1927. The report of recent progress in the United States was presented by Andrew W. Decora of the Laramie (Wyoming) Energy Research Center.

"Based on results to date," he concludes, "the potential for underground coal gasification looks extremely promising." The land surface is not disturbed so reclamation is no problem. Sulfur can be removed, reducing air pollution when the gas is eventually burned. Less fresh water is required than other gasification methods. And all the residue is left in the underground seam.

Unfortunately, more development is needed, and a pilot plant for actually generating commercial electricity will not be ready until 1980, or later. Also, the effects on groundwater have not yet been fully explored. Economic feasibility, Decora says, is purely speculative at the moment, but preliminary calculations indicate that underground gasification should eventually become a competitive method of extracting clean energy from coal. □