

WHEN THE LEVEE BREAKS

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The floods that devastated the Mississippi and Missouri river valleys in 1993 have created two questions: Is our approach to flood control correct? And where do we go from here?

The cost of the damages incurred by the floods along the Mississippi and Missouri rivers last spring quickly rise into the surreal realm of "about \$10 billion," but real those damages are, and it will take real money and work to repair them. As the cleanup continues, so does a dispute over the nation's approach to floodplain hazards and whether damages on this scale can be prevented by better management of the floodplain and of the risks to its residents.

What the phrase "better floodplain management" entails is a burning issue both along the river and in Washington, D.C., but there are three questions that any policy must address: Why were the floods as bad as they were? Are they likely to recur? Could any system have prevented the damage?

Seasonal flooding is not uncommon on the upper Mississippi, and the spring of 1993 began as spring in the Midwest usually does, with rains and melting snow. But with the ground still soaked from the previous autumn's rains, the new moisture became runoff that swelled the rivers and caused minor flooding. This was not unusual, but what happened next was.

Starting in April 1993, the region experienced almost four solid months of rain as a persistent pressure system sat off the Southeastern U.S., pulling wet air up from the Gulf of Mexico, and cold air from a lower-than-normal-latitude jet stream turned that moisture into record-breaking precipitation over Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota and Wisconsin, according to Frank Lepore of the National Weather Service.

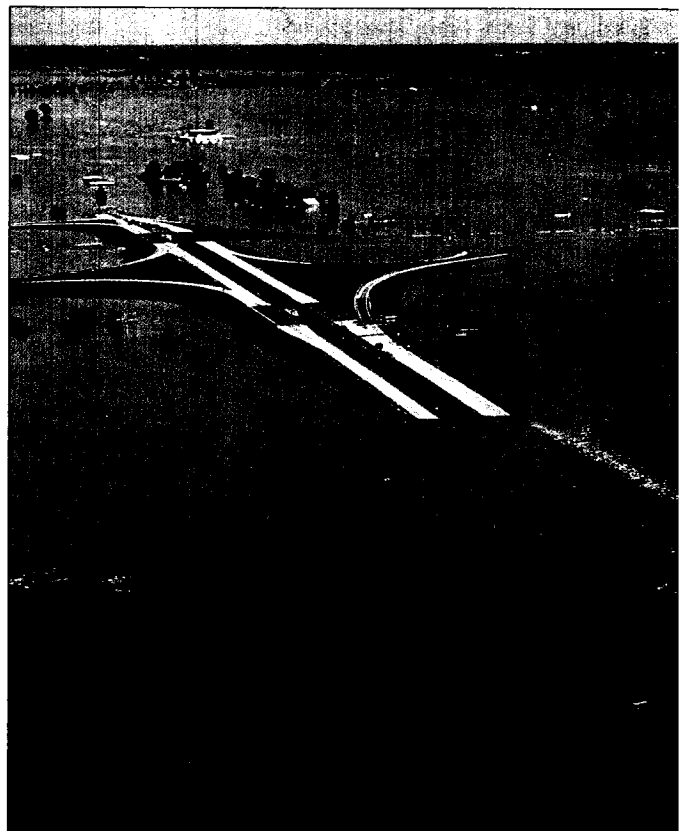
The result: almost 1,000 mi of the Mississippi and Missouri rivers rose beyond their normal flood levels, deluging 16,000 sq mi of land. Nearly 800 of the region's 1,300 levees were overtopped or damaged and 50 people died.

The flood ravaged both residential and commercial buildings, washed out roadways and bridges, disrupted water supplies and sewer systems, and carried raw sewage and industrial wastes into the river. Crop losses totaled more than \$2 billion, and miles of farmland were severely damaged. In Missouri alone, 450,000 acres of soil were covered with sand up to 8 ft deep. According to Larry Zensinger, chief of interagency planning for the Federal Emergency Management Agency (FEMA),

60% of those nine states, totaling 10% of the land area of the 48 contiguous states, were declared federal disaster areas.

Most agree that the flood was the worst the area had seen this century, possibly even bigger than the flood of 1844, which is estimated to be the biggest on record. The label frequently applied—that this was a 100-year flood or a 500-year flood—indicates the flood's severity but does not imply that it will be a century or more before a flood so severe happens again. It merely means that there is one chance in 100 or 500 that such a flood will occur in any given year.

Currently, the U.S. Army Corps of Engineers and the U.S. Department of Agriculture's Soil Conservation Service (SCS) are working to repair the levees before this spring's rain. The Corps is inspecting and repairing the 229 federal levees it designed and built, 109 of which were damaged or overtopped. It is also fixing some 160 vital agricultural levees that meet Corps requirements



THE MISSOURI WASHES OVER INTERSTATE 54, IN THE CEDAR CITY SECTION OF JEFFERSON CITY, MO. ON THE SOUTH SIDE OF THE RIVER, MOST OF DOWNTOWN JEFFERSON CITY SITS ON A BLUFF, ESCAPING SERIOUS DAMAGE DESPITE WATERS THAT ROSE 25 FT ABOVE FLOOD STAGE. PHOTO BY JONAS JORDAN, U.S. ARMY CORPS OF ENGINEERS, SAVANNAH (GA.) DISTRICT.

and protect large areas along the two main rivers.

SCS has the larger job, numberwise if not dollarwise, of helping state and private levee districts rebuild the hundreds of agricultural levees along tributary rivers. SCS, FEMA, and the U.S. Fish and Wildlife Service all offer levee owners the option of taking money to leave an area open to flooding. However, few are pursuing the offer.

Both agencies are working as fast as possible, but as millions of dollars go into the recovery, many engineers are asking if it isn't time to step back and re-evaluate the nation's haphazardly developed policy of flood control on the Missouri and upper Mississippi.

LEANING ON LEVEES

The policy has its roots in the same past as the one in place for the lower half of the Mississippi but has come to different results. On the lower half of the river, the Corps followed a levees-only method of flood control until the disastrous flood of 1927, after which the Jadwin Act authorized the use of reservoirs, fuse dikes and floodplain storage below the mouth of the Ohio River. The Flood Control Act of 1937 followed, which finally gave the federal government a legal role in regional flood control, created SCS to protect agricultural land and recommended the use of reservoirs to store flood peaks.

Over time, various flood-control acts have resulted in a nearly continuous system of levees, set thousands of feet back from the river, from the Ohio River to the Gulf of Mexico. Federal flood insurance was first made available in 1968, and FEMA was created in 1979 to help cope with disasters. Since the system has been in place, flooding has not been nearly as much a problem on the lower Mississippi.

The Pick-Sloan Program, an attempt authorized by the

Flood Control Act of 1944 to duplicate that type of regionwide effort on the Missouri, was only a partial success. The reservoirs were constructed, but many property owners decided they didn't want the levees set back several thousand feet from the river or see their riparian land designated for low-intensity use. "When push came to shove," says James Durkay, the Corps' assistant director of civil works, "we found that the property owners call the shots down on the floodplains."

On the upper Mississippi, the Corps has been assigned a number of projects to construct levees associated with locks and dams as well as flood walls to protect the larger cities against 100-year floods. However, unlike what it did for the lower basin, Congress never authorized a systemwide approach to the upper part of the river.

Primarily without federal assistance, state and private groups erected more than 1,000 agricultural levees along the rivers. Most were designed for 20-year flood-level protection. Counting both federal and nonfederal projects, there are now more than 190 reservoirs and water-impoundment structures on the two rivers. Speeding the passage of water to these structures are miles of channels that the Corps has constructed.

Has the investment—\$25 billion in federally funded flood-control projects through the Corps alone—been successful? The Corps estimates the levees averted an additional \$11 billion in damages. Others are more conservative. "The presence of levees prevented an additional \$2 billion dollars in damages," according to Jim Van Burén, a vice president with Sverdrup Corp., St. Louis. Along that city's flood wall, for example, the river crested at 49 ft, 20 ft above the normal flood level. The text of a Sverdrup presentation on the flood added that the levees fared poorly because last year's flood was a 500-year event, one well beyond the bounds of a reasonable design.

To others, however, levees prevent smaller floods at the expense of making larger ones worse. "Flood damages, in constant dollars, are greater today than before the 1936 Flood Control Act," says Don Hey of Wetlands Research, Inc., Chicago. "Channelizing speeds flow, causing erosion."

By constricting the river's flood area, levees cause flows to run higher, but whether the effect is local or raises flow levels all along the river is a matter of debate. Although the volume of water passed was lower this year than in 1844, "there was a 10 ft increase in the flood stage," says Richard Sparks of the Illinois Natural History Survey, Havana, Ill. Gary Dyhouse, chief of hydrology with the Corps' St. Louis office, disagrees. He says that the effects of levees are local and that the comparison of the two floods is irrelevant. "Most historical floods, which played a big part in levee design, were overestimated by 25%."

Regardless, many river managers are finding that trying to control a river often makes it more unmanageable, according to Phil Williams, a consulting engineer in San Francisco. Due to channelization of the Rhine River in Germany, he says, "what was a 200-year flood is now a 60-year event."

Many doubt that any reasonable structurally based system, based on what was in place last spring, could have held back the floods. James Durkay, the assistant director of civil works for the Corps, says: "Agricultural levees down near the river have to be constructed to fail. You couldn't build them high enough to contain that volume of water." Robert Bartels, SCS' emergency-watershed-protection coordinator for the nine flood



states, agrees: "not unless you're going to create tremendous storage capacity upstream, and the cost of that I don't think you can justify."

THE FUTURE'S NONSTRUCTURAL STRUCTURE?

At FEMA, Zensinger has identified several trends in floodplain management. They point toward projects that are nonstructural in nature, share costs between local and federal agencies, satisfy multiple objectives, encourage natural land use and are based on local initiatives. Regarding structural vs. nonstructural methods, Durkay says, "it's unlikely you'll see more reservoirs or more levees." Instead, the big question seems to be what kind of nonstructural methods will be most common in the flood-management systems of the future? A \$2 million Corps study of these and other issues was authorized by Congress last fall.

For many, the end result is more important than the methods. "We all want to see restoration, but with some mitigation to make sure that when the Mississippi floods again—and it will flood again—its effects are mitigated," says Jon Kussler, head of the Association of State Wetlands Managers, Berne, N.Y. "Our primary requirement is that agriculture remain a significant part of the management of the floodplain," says Kyle Vickers, assistant secretary of the Missouri Department of Agriculture. "One-half to two-thirds of our production is in bottomland acres."

Nonstructural methods all share one feature: Some land must be allowed to flood so other parts can stay dry. One option, inadvertently put to use last year, is to let some farmland flood to save other areas, including the cities. On the lower Mississippi, for example, the levees are set back up to 1 mi from the river to create a larger flood zone. "Some lands that are farmed are on the wrong side of the levees," says Durkay. "But the farmers expect to lose those crops more frequently."

Low-level levees can be designed to break and store a large volume of floodwater in the plains behind them. "We would still need to protect the transportation network and people's livelihoods," says Bartels. He added that farmhouses and equipment sheds can be elevated or surrounded by dikes. "We've already done this in the Red River Valley."

Another alternative is to simply move out of the floodplain completely and let the river run its course. Hundreds of municipalities have expressed an interest in this approach to FEMA, and several, including Valmeyer, Ill., are moving the entire town to higher ground. But a town need not be small to consider this approach. After flooding on the Arkansas River had made Tulsa, Okla. the subject of nine federal disaster declarations in 15 years, the city developed a plan of retreat they put into action right after the 1984 Memorial Day flood.

"Within two weeks, we had designated high-hazard areas where no one would be allowed to rebuild," says Dale Reynolds, an engineer with Tulsa's planning board. The city bought out property owners within the flood zone and converted the land into riverside parks. "Most agencies aim to get people back into their homes," says Reynolds. "All that does is invest federal money in a future disaster. Flood-loss reduction must become the central point of flood response."

Davenport, Iowa, takes a different approach. They let the town flood. According to Kathy Wine, a spokeswoman for River

Action, Inc., a Davenport-based citizen's riverfront development group, the city was approached several times by the Corps to build a levee, at an initial cost of some \$50 million plus \$250,000 in annual maintenance. Instead, the flood cost them only \$3.1 million in city-area public damages and \$4.2 million in damages to private homes in the surrounding Scott County area. "We feel we saved the taxpayers a lot of money," says Wine.

The city is now creating a fund to buy up homes along the river and is further encouraging businesses to protect their buildings against future floods. One such building, a hotel under construction on the waterfront, stands above the 100-year flood level by sitting on top of its parking garage.

Floods can also be stored on wetlands, which both engineers and environmentalists agree help to dampen floods and prevent erosion. "Watersheds that have retained a large percentage of the original wetlands have lower peak flows during flood events," says Scott Faber, director of floodplain programs for American Rivers, Washington, D.C. "[But] it's got to be a wetland in a certain space, surrounded by a certain landscape, to have flood-control value."

However, the limits of storing floodwaters on the plains may have been demonstrated by this flood. As Durkay points out, "Since the agricultural levees all failed, we had as much storage area as there is between the bluffs." Despite that, areas downstream from the breaks still faced flood threats.

Both the Corps and scs have programs to restore wetlands and buy land from farmers if the land has value as a wetland, but both are currently limited by funds and by their mandates from pursuing as many opportunities for restoration as are available in the wake of the flood. The type of wetlands re-created are important. Many of the areas original wetlands were bottomland forests that pass water so slowly they could create the same backwater problems that levees do, according to Durkay. "Grassy wetlands, areas that are low and flat will transmit water well, but agricultural land shares that quality."

Masses of trees can help retain soil, however. On an 8,000 acre spit of land near Charleston, Mo., some 70,000 tons of topsoil had been lost in each previous flood event. In 1986, residents, working closely with the Corps, scs, the Missouri Department of Conservation and others, planted 130,000 trees in strategically placed screen lines of cottonwood, green ash and pecan. All the plantings were on private lands, according to Lester Goodin of the area's Buffalo Band Levee Association. "This year we've had no net loss. We got sand, yes, but the trees held and prevented erosion."

The natural approach has its limits, however, as even Hernando de Soto's explorers witnessed floods on the river that spread from bluff to bluff back in 1541, when the land was completely undeveloped. "To what point in time do we want to restore? A farmer will say, 'just before the flood'; a sportsman would go back 100 years. Why not the Pleistocene epoch? I happen to like the early Holocene," says Hey.

Gilbert White of the Natural Hazards Research and Applications Information Center, Boulder, Colo., favors using a variety of approaches to floodplain management. "There is no single solution. What is needed is a careful assessment of options in different places and times."

As a junior staffer in the Executive Office of the White

House, White was a critic of the 1936 Flood Control Act during its passage. His research into, and criticism of, federal policy has continued since then. The nature of many of those policies is likely to change as a result of last year's disaster.

"I see both the environmental people and the Corps moving in that direction," White says. "At the Corps, there are two counter bottom-up movements. Some engineers ... are going to get on with repairs right away. Others want to seize the opportunity to step back and get a little balance in what they've been doing."

White feels that a careful mix of structural and non-structural designs could have passed the flood with much less damage to urban areas. "In some places it would be well to let the river have its course. In some, use the land for agriculture, with the expectation that it will be flooded fairly frequently, every 20 years or so. In some areas, it would be alright to have the community flood-proofed so buildings are protected but the agricultural lands flood."

Currently, the White House Office of Environmental Policy is holding weekly meetings with a number of other agencies to study the issues raised by the flood, with the hopes of having a consistent policy ready when the Mississippi River floods again, as many expect it to this spring.

FEDERAL OR LOCAL INITIATIVES?

That policy will likely be a list of options open to those affected by the flooding, possibly including buyouts, restoration, elevation of important structures and setting aside of tracts that will become wetlands.

Will Stelle, a member of the White House Office of Environmental Policy, listed two guidelines for the effort. "[First,] we don't need to reinvent the wheel. There is enormous expertise on the state and federal level. Second, this is not just a federal issue. I don't see the need for some federal interstate floodplain-management regime taking over local decisions." Regional efforts are likely only if "it is the judgment of the states and the communities that is the way to proceed."

scs' Bartels agrees that the state role is important. "I think that where they've got effective floodplain management, the states and local authorities are making the strongest calls," he says, citing Illinois, Iowa and Wisconsin as examples. "You did see a lot less general damage there, for all the flooding, than you had in other states." But he adds that a regional plan will most likely be successful if it is jointly developed by the states

and the federal government. "The main problem is telling the individual what is and is not allowed on the floodplain. This, to me, means applying uniform national standards."

Others, however, feel that the federal government needs to play a stronger role. Dan Willard, a researcher at Indiana University, is blunt: "Watersheds should be in one political system." Vickers adds, "We drain 10 states in the Missouri River, and Corps lake policy in Montana has as much to do with our floodplain management as what we do in Jefferson City. Voluntary state associations probably won't work very well, so we'll have to have some direction from the federal government."

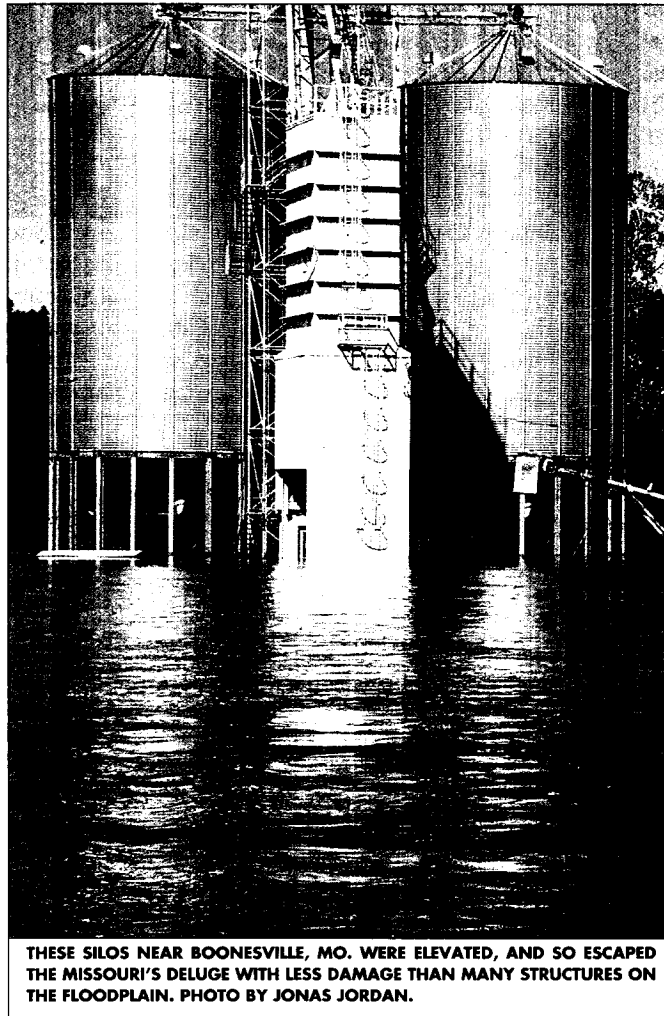
Durkay believes that any such program will need the support of the property owners along the river, "but it's not clear at this point that [they] are prepared to sign up," he says. As the extent of the damage becomes clearer, however, he adds that they may change their minds.

Another policy element that will have to be reviewed is the role of federal insurance, for both crops losses and floods damages. "We can't separate the farm insurance policy from the levees," says Vickers. "Levees are just another form of insurance." The Federal Insurance Administration, adds White, "has not inspired mitigation approaches by those who buy the policy, unlike fire and boiler insurance." He feels that changing the costs of insurance

to reflect flood hazards better, as well as possible methods of coping with them, would encourage people to leave the floodplain or find measures to reduce their vulnerability to flood damage.

While policy debates are getting under way in Washington, levee rebuilding along the rivers is moving as fast as possible, making time of the essence for reaching broad-ranging policy decisions. "By the time they study it, every farmer will have put his agricultural levee back in," says Van Buren, who added that it would be difficult to get the farmers to remove them.

Whatever policy is developed—whether it is biased toward levee reconstruction or wetlands restoration, or whether it mixes the two—it will have a broad range of social and economic effects on the residents of the flood states. "Twenty years ago, we might have said that it's just time for the Corps to develop some projects," says Stelle. "But its not so simple any more." The key, according to Willard, is to design with nature. "The river," he says, "will always win a fight with you." ♡



THESE SILOS NEAR BOONESVILLE, MO. WERE ELEVATED, AND SO ESCAPED THE MISSOURI'S DELUGE WITH LESS DAMAGE THAN MANY STRUCTURES ON THE FLOODPLAIN. PHOTO BY JONAS JORDAN.