Texas Water Resources Institute

Fall 1990
Volume 16
No. 3

FINDING ANSWERS TO FLOODING WOES

Federal Policies, Unsound Development, and Reservoir Operations All Contribute to Flood Problems

by Ric Jensen
Information Specialist, TWRI

The Trinity River Blues

"That dirty old Trinity River sure has done me wrong It came in my window and doors and now all my things are gone Trinity River Blues keep me bothered all the time l lost my clothes. ...believe I'm gonna lose my mind They done built a levee, I have no more worry about If that river should happen to rise I'm gonna have to move my things out Trinity River rising, it came in my windows and doors.,'

- Blues song by Aaron "T-Bone" Walker (1929)

This summer - as was the case in all too many previous summers - floods ravaged the Trinity River.

Record floodwaters (fed by intense rains in the first five months of 1990) made the Trinity River roar through the Dallas-Fort Worth area and then sweep downstream where it produced widespread flooding. Hardest hit was Liberty County downstream of Livingston Dam. The Red and Brazos rivers also spilled over their banks causing additional havoc.

The floods produced major damages. Roughly 6,000 individuals from 68 counties applied for federal disaster assistance. Only half of those counties (34) participate in federal floodplain management and flood insurance programs. Many homes and businesses were destroyed and, in the area below Livingston Dam, 200 homes were destroyed and 4,000 people were forced from their homes. Agricultural losses were estimated at up to $1 billion as crops were flooded before they could be harvested, topsoil was washed away, and livestock drowned. The impacts even reached Galveston Bay where the floods diluted saline water so much that oysters died.

How great were this year's floods? This year's floods set new records for high water on the Trinity river near Liberty, breaking those that were set before Livingston Dam was even built. At its apex, releases from Livingston Dam totaled 108,000 cubic feet per second (cfs). That's enough water to fill 1,200 swimming pools in less than a minute and to fill the Astrodome with water in only 12 minutes. Only a series of flood control dams held the floodwaters in check and kept the damages from being worse. This year's flood flows in downtown Dallas were 81,000 cfs (the third highest on record) with the dams in place. If the dams had not been there, Corps' officials say flows could have been greater than 260,000 cfs (the worst ever recorded in the Dallas area).

Are building flood control dams and other structures the best way to cut flood damages? Some critics say that structural measures like large dams provide a false sense of security that makes people feel they are safe from flooding. Structural measures are also expensive and can result in catastrophic losses if they fail.

Non-structural alternatives include managing existing water supply dams to mitigate floods during emergencies, preventing construction in low-lying areas, lessening the impacts of urbanization, and increasing the effectiveness of flood insurance and floodplain management programs.

Steps are being taken that could lessen potential flood losses. The Corps of Engineers, the North Central Texas Council of Governments (NCTCOG), and local governments are developing a holistic plan to menage the upper Trinity River. Studies are assessing the impact of floods depending on the amount of development that's allowed in low-lying areas. Development in the region's floodplain is being regulated by establishing uniform criteria. Harris County is building computer models to provide a better idea of how many homes and businesses have been built in low-lying areas. The Harris County Flood Control District requires new developments to include provisions to temporarily store stormwater runoff. The U.S. Geological Survey (USGS) is working with state agencies to improve models to simulate flows in the Trinity River basin and to identify high risk areas.

Dam building and dam management is being reviewed. Some politicians are calling for studies to see if more flood control dams (like the proposed Tennessee Colony project) are needed on the Trinity. State legislators have formed a task force to study if reservoir management strategies could be altered in the future to reduce flood risks.

CONTROLLING FLOOD LOSSES

To understand why this year's flooding caused as much damage as it did, a number of basic issues must be explained and some misconceptions need to be clarified.

There are two ways to mitigate flooding. Structural measures include dams, channels, levees, stormwater drainage systems and other public works that manage stormwater runoff. Structural approaches have been widely used in Texas. Examples include flood control dams, widespread construction of levees to protect low-lying areas, improved channelization and drainage, and planning of huge tunnels to move stormwaters away from urbanized areas in Austin and San Antonio.

Some experts have recently criticized an overreliance on structural measures because dams can fail in severe floods and levees may be overtopped by high water. Structural measures may also give people a false sense of security that encourages additional floodplain development.

On the other hand, non-structural measures are strategies that persuade people not to build in areas that are likely to be flooded. These include zoning and planning, tax incentives, flood insurance programs, relocation of buildings and communities, and other measures.

It first needs to be understood that not all dams are designed and/or operated to control flooding.

The federal government, through the U.S. Army Corps of Engineers, builds flood control reservoirs throughout Texas. The rationale is that flood control projects are in the broad national interest and wouldn't be economical for local sponsors to construct. Recent studies indicate that federal financing of flood control dams may no longer be financially viable (Wurbs, 1988). Many Corps of Engineers' projects serve many purposes and provide water supplies, recreation, and flood control.

Operating flood control reservoirs typically utilizes a strategy of leaving a set amount of storage empty to hold incoming floodwaters. Flood control dams usually release water more slowly than it's flowing into the reservoir. Otherwise, owners and operators could be charged with causing flooding before it would have begun if the reservoirs were not in place.

Water supply reservoirs are often built by local entities. Cities and others in need of water supplies typically sell bonds in exchange for a set amount of storage capacity. The goal in

operating a water supply dam is to keep the reservoir as full of water as possible to guard against droughts. Unfortunately, if large amounts of water are stored in the reservoir, there isn't much room to buffer against floods.

During severe floods, the conflicting goals of water supply and flood control can become pronounced as they did during this year's flooding at Lake Livingston - a water supply dam with no flood control storage.

Those who have paid to develop water supplies don't want to release water prematurely or unnecessarily. After all, no one knows when floods end and droughts begin. Conversely, prereleases of water to make way for anticipated rainfall and runoff may ease the risk of minor flooding.

FACTORS THAT INCREASE FLOOD RISK

Urbanization -the construction of buildings and the paving of sidewalks and streets - increases both the speed and the amount of runoff. Water that would usually soak into soils after a rainfall can't penetrate paved streets and parking lots. Instead, it just runs off, picking up speed as it goes.

Other aspects of urbanization also heighten the chance of flooding. Many cities in Texas have allowed extensive residential and commercial development in lowlying areas that are likely to be flooded. Many low-lying areas are typically referred to as 100-year floodplains. Typical rainfall and runoff should result in a 1 % chance of these lands being flooded in any given year or once every 100 years. Just because a 100-year floodplain was flooded this year, that doesn't mean it's safe from flooding until 2090. Areas that are less likely to be flooded include 200- year and 500-year floodplains, while areas that are more likely to flood include 25- and 50- year floodplains.

The amount of construction that has occurred in low-lying floodplains isn't well known and this constitutes another part of the problem. Many areas of Texas do not regulate floodplain development. In some cases, local governments have only a rough idea of where development is taking place and don't discover problems until areas are under water. Some estimates suggest that Texas has 20 million acres of flood-prone property - the most of any State - and that 11% of the State lies within 100-year floodplains (Thomas, 1989). Roughly 1.3 million properties worth $55 billion are at risk from being sited in floodplains.

The impact of flood risks and floodplain management laws on land values is unclear. Recent floods may reduce land values and prospects for development. Some studies (Burby,1988) suggest that strict enforcement of ordinances that limit development in floodplains lowers land values.

The Federal Emergency Management Agency (FEMA) estimates that roughly 675,000 households in Texas are located in flood hazard areas, yet 67% of may not be covered by federal flood insurance. On a national level, estimates suggest that the number of

households located in 100-year floodplains has grown by 40% in the past 25 years, in part because more than 50 federal agencies encourage development in coastal areas (Milleman and Jones, 1989).

Studies by the Corps of Engineers have simulated the cumulative impacts of flooding in the Dallas-Fort Worth area based on different levels of floodplain development, and have evaluated the impact of structural and non-structural measures to reduce losses. The studies (Corps of Engineers, 1990) illustrate the impact of floodplain development on increasing flood risks.

The Corps evaluated current and future flood damages that could be caused by a standard project flood (a flood resulting from the worst rainfall that could be expected in a region). The studies compared the impacts of virtually uncontrolled development and floodplain management programs. Results suggest that damages from a major flood could total more than $11 billion if floodplain development is unregulated. A comprehensive floodplain management program could cut losses to $4 billion. If a major flood occurred now, four major levee systems in the area could be overtopped with high water and damages could be more than $3.7 billion.

To lessen flood risks, local governments have endorsed a corridor development certificate process to coordinate future development by requiring more stringent permit criteria. Structural and nonstructural ways of cutting flood losses are being identified. Computer models and geographic information systems that accurately reflect the impacts of new construction in floodplains are being developed.

FEMA's National Flood Insurance Program (NFIP) provides solutions to many of these problems. The NFIP identifies areas where flooding is likely and produces maps that display problem areas. NFIP provides flood insurance to local counties and communities that participate in the program and discourage unsound floodplain development. This includes land use management regulations, floodproofing and elevation of existing structures, and other measures.

Many Texas counties and communities participate in the NFIP and Texas is third nationally in the number of federal flood insurance policies in effect (225,000).

Texas also ranks second nationally in the number and amount of claims paid (55,862 claims have been paid for $575 million) and second in repetitive losses (Thomas, 1989).

Has FEMA has not done enough to discourage development in flood prone areas? Some studies say that the actual flood damage potential has increased by roughly 5%, even in areas that have floodplain management programs in place. Potential flood losses would have risen by 65% if floodplain management programs had not been utilized (Burby, 1988). More than $5 billion of flood insurance policies have been issued in high hazard zones that are especially vulnerable to flooding.

Other studies (GAO, 1988) suggest that more than 40% of the claims NFIP pays are for repetitive losses and more than $500 million has been paid for such claims (Milleman and Jones, 1989). More than half the losses were in coastal communities. Some critics allege that the NFIP provides incentives for individuals to increase their exposure to flood losses and increases floodplain development by providing insurance to those who build in low-lying areas (Burby, 1988). NFIP says that it discourages development in floodplains by charging higher premiums in those areas.

Another key issue is whether NFIP has the funds it would need to pay claims in a year when large numbers of natural disasters took place. A 1988 audit of the program (GAO) showed that a year of catastrophic flooding could result in losses of more than $4 billion even though current premiums total less than $500 million annually.

The Texas Water Commission is working with FEMA to help counties and communities carry out floodplain management programs. The community rating system, for example, cuts insurance rates when local governments lessen flood risks by preserving open spaces and not allowing development in floodplains, minimizing the impact of stormwater runoff, mitigating losses in often-flooded areas, and maintaining levees and drainage systems (Community Rating System, 1990).

THE TEXAS FLOODS OF 1990: UPSTREAM FLOODING

In just a few hours of late April and early May, as much as 18 inches of rain fell on already saturated ground in Parker County. According to some estimates, 90% of the rain that fell ran off directly into rivers and lakes because the soils couldn't absorb more. The storms caused localized flooding and filled many reservoirs to overflowing including Lake Brownwood which crested nearly 7 feet over its spillway, surpassing records that were set 30 years ago. The rains also forced the Brazos River Authority to dramatically increase releases from area reservoirs. Releases of 38,000 cfs from Possum Kingdom Lake and 58,000 cfs from Lake Granbury were typical.

Many homes and businesses were damaged. In the Horseshoe Bend subdivision near Weatherford, 60% of the homes were under water and some resdoemts claimed they weren't notified that large releases from the dam were coming their way. In downtown Brownwood, losses were estimated at $15 million and some called it the worst disaster to ever hit the area. To make matters worse, Brown, Comanche and Erath counties had never joined federal flood insurance programs and Parker County left the program in 1981. Consequently, many forms of federal aid were unavailable following the floods.

THE RED RIVER OVERFLOWS

On the Red River, heavy rains also created extensive flooding. Traffic backed up five miles near Dennison Dam as onlookers watched the water flow over the dam's 1,500-foot spillway for the first time since 1957. Behind the dam, Lake Texoma had grown from its normal size of roughly 90,000 acres to nearly 150,000 acres. Later, spectators viewed the flooding on the Red River as less of a spectacle and more of a crisis. When high flows on

the Red River neared Texarkana, the river swelled from its normal width of a half-mile to 10 miles in places.

A key question was whether the levees could stand up to the high water or if they would collapse and cause even greater damage. To shore up the levees, 400 national guardsmen were called out to reinforce the levee with 30,000 sandbags. Some officials gave the levees only a 50% chance of surviving the floods because the constant pressure of water against them could force the levees to fail. A 60-foot section broke and floodwaters were just inches from the top of the 10- foot levees. An emergency official said that walking on the levees was like "walking on Jell-O" and reported that stepping on a vulnerable levee sent ripples across a nearby street.

Corps of Engineers officials estimated that Lake Texoma and other reservoirs reduced peak river levels by 6 to 12 feet in many places, and projected that lakes and levees along the river avoided more than $2 billion in property damages.

FLOODED CROPS, DEVASTATING EROSION

Many of the damages, particularly in upstream areas, resulted in devastating losses to agriculture (see Figure 1).

The Texas Department of Agriculture estimates losses to crops and livestock at $500 to $700 million. Meanwhile, Texas A&M University Agricultural Economist Carl Anderson suggests that losses could top $ 1 billion when soil erosion, damage to the environment, losses to the recreation, tourism and camping industries, and property destruction are factored in.

The adverse impacts fall into two major categories- crop losses and erosion. Estimates suggest that the floods may have destroyed most of the wheat and up to half of the corn and sorghum crops in a 41 county area. Agricultural production along the Trinity River suffered severe losses and cotton and grain sorghum crops in the region were virtually destroyed.

Because the floods came after farmers had freshly plowed their fields to plant crops, erosion was especially heavy. Estimates from the U.S. Department of Agriculture's Soil Conservation Service suggest that up to 5 tons of soil per acre (roughly a dime in thickness) eroded from Texas croplands. Flooding near the Red River produced as much as 30 tons of erosion an acre and carved gullies 10 feet deep into croplands. Besides increasing siltation in area rivers and lakes, the loss of topsoil could be especially damaging in the future because it will take years to replace.

A "HUGE FUNNEL" POINTED AT LAKE LIVINGSTON

The storms caused extensive damage in Dallas and Fort Worth. The Trinity River crested at 6 feet over flood stage in many areas, while the West Fork of the Trinity crested at a depth of 48 feet (its third deepest level ever). Much of the worst flooding was in south

Dallas areas that were not protected by a levee where nearly 400 people were forced from their homes. After the floods, extending the levee to south Dallas has become a high priority. Floodwaters topped spillways at many dams including Eagle Mountain, Lake Worth, and Lake Bridgeport. The flooding in the Dallas area could have been much worse if flood control dams had not been built (see Figure 2).

The upstream rainfall produced major flooding downstream. Runoff was coming of 81,000 cfs from Dallas was merging with flows of 40,000 cfs from Navarro and Henderson counties. An official with the National Weather Service said the river "was going crazy...it was so big it looked like a lake instead of a river." At some places, the river had swollen to 10 miles wide. The runoff converged just upstream from Lake Livingston. A Trinity River Authority (TRA) official said: "This large section of the watershed is overflowing..it's like a huge funnel pointing directly at Lake Livingston and the lower Trinity."

The crisis reached its peak in mid-May when runoff arrived from upstream areas and the Trinity reached an all-time record crest of 29 feet near Liberty (5 feet above flood stage). TRA then began releasing flows from Lake Livingston of roughly 108,000 cfs over a week-long period. The total amount of water that was released was equal to 40% of Houston's annual water supply. Only the absence of extra rain kept the situation from being even worse.

The impact of storms could be felt far downstream. Texas oystermen estimated that half the oysters in Galveston Bay could be lost because of reduced salinities.

FLOODPLAIN DEVELOPMENT PUTS PEOPLE AT RISK

By early May, TRA officials were warning residents that flood flows were on the way and urged them to evacuate and "head for higher ground." Unfortunately, many people had built on low-lying properties.

Why did so many people decide to build in floodplains below Livingston Dam? Properties with creeks or nearby lakes are beautiful when they aren't being flooded. Also, many people who developed property
below Livingston were newcomers to the area who may not have comprehended or cared about the flood risks.

Although some people were ignorant of the risk of the area to flooding, others built in the area even though they knew TRA had the right to temporarily flood their lands. TRA bought the rights to occasionally flood lands around the lake itself (but not downstream) when the lake was too full. Some people still built homes on these areas.

Only a few people actually evacuated during the floods. Most stayed to guard their homes and possessions from looting. Others stayed in the surrounding area during the floods and said they would probably return after the floodwaters subsided. Even if they wanted to

sell their homes, they couldn't find buyers who would give them the price they originally paid.

A key lesson that was reinforced from the flooding was that homes and businesses built in low- lying floodplains are more likely to be devastated when a flood occurs. Roughly 4,000 people were forced from their homes in the area immediately downstream of Lake Livingston because of the flooding. Roughly 200 homes in low-lying subdivisions were destroyed and losses were estimated at more than $11 million.

"As long as people are living in the floodplain we'll have problems," said a TRA spokesman. "Is the problem that the Trinity River floods below the dam or is the problem that people are living in the floodplain? People have to realize that the low-lying land below Livingston Dam is a floodplain. It has flooded since time immemorial and will almost certainly flood again. There's absolutely nothing TRA can do to provide flood relief to those poor, beleaguered people downstream. Many of those people simply live somewhere they probably shouldn't."

COULD PRERELEASES HELP?

One of the controversies surrounding this year's flooding was whether prereleases ought to be made from Lake Livingston. Liberty County officials and people who live near the river bottom contend that there would be little or no flooding below the dam if TRA would lower its lake levels before heavy rains hit. They want the water supply dam operated as a flood control reservoir.

TRA argued that prereleases would not have lessened the flooding because too much rain fell. The amount that could have been prereleased was only a fraction of the water that reached the lake. Prereleasing could also have caused minor flooding. Even if the floodgates had been opened earlier to allow flows of 100,000 cfs to leave the lake, it would have taken 63 days to empty the reservoir because rainfall and runoff still would have filled the lake more than 3 times, TRA said. Others say that even if the lake was drained it would have been filled to overflowing in a few days.

One reason prereleases were not made was a fear that the practice might diminish water rights in the lake that cities have paid to develop. Prereleasing water now might limit water rights in the future by setting a precedent in which TRA would be obligated to release water before every potential flood. It should be noted that only half of the water supplies in Lake Livingston are now being used by the City of Houston and TRA.

Not everyone agrees that Prereleasing is impractical. A Liberty County judge argued that TRA could release floodwaters in advance of storms based on weather forecasts. No water supplies would be lost and the risk of flooding would be reduced if rains fell as predicted. If the weather forecasts were inaccurate, water supply problems could develop. Prereleasing may be a viable strategy when small amounts of water that won't cause flooding are released.

Potential solutions have been proposed. Those interested in using Livingston as a flood control dam could buy wafer rights in the lake and dedicate them to flood control (if there were willing sellers). The Corps is investigating whether new flood control dams could be built upstream of Fort Worth or above Lake Livingston at Tennessee Colony. The Texas Legislature has created a task force to review flood control operations in the region and to study the impact of reservoir releases during floods.

FEDERAL FLOOD RELIEF EFFORTS

Many flooded residents from throughout Texas qualified for disaster relief from federal agencies. NFIP identifies communities that are vulnerable to flooding and produces maps that show the boundaries of floodplains and other areas that are likely to be flooded. NFIP then makes federal flood insurance available if communities enact floodplain management ordinances and take steps to reduce flood risks.

There may not be much sympathy for those who continually rebuild in floodplains and regularly suffer flood damages, only to be reimbursed by NFIP. An editorial in The Dallas Morning News commented on the situation this way. "It seems reasonable with all that is known about floods that no structure should be allowed in the floodplain that is below the level of the expected water rise, no matter how many years it has been there. It would be cheaper to relocate people before a flood than to handle a disaster. If people wish to continue living as they have then they should not be able to [do so] at taxpayer expense."

Banks are supposed to verify that those who borrow money for developments within designated floodplains purchase flood insurance and keep those policies active over the life of the loan. Only a small percent of banks may be requiring that people who take out loans to buy properties in floodplains actually buy flood insurance (Rose, 1988). Many borrowers are not keeping their flood insurance policies active after initially taking out loans. Another recent study (GAO, 1990) reports that nearly 80% of properties in Texas that were required to be covered by flood insurance are uninsured.

In many areas of the state, floodplain management and participation in FEMA programs is controversial. No one wants to endanger lives and property to the potential risk of flooding. However, floodplain management makes it clear that some properties are in danger from flooding and some argue this reduces their market value. Residents are often required to elevate or floodproof homes and other structures which can be expensive. In Houston, ordinances require that part of new lands being developed be set aside to control stormwater runoff (Corps of Engineers, 1988). Others don't like the idea that a federal agency can tell them where they can and can't build.

Parker County commissioners voted to leave the FEMA program a few years ago because some residents didn't want to elevate mobile homes and other structures. Parker County received limited federal aid after this year's floods and later reapplied to the FEMA program and was readmitted. Since rejoining the program, Parker County has been

identifying properties that were damaged in previous floods, requiring the elevation of some buildings, and adopting maps with the 100-year floodplain.

Local reaction to the NFIP program is mixed. Following last year's and this year's floods, roughly seven counties and seven communities have joined the NFIP. Palo Pinto County was recently debating whether or not to join the program. Burnet County protested detailed maps by FEMA showing where flooding was likely.

SUMMARY

Texas received a great deal of rainfall earlier this summer. Obviously, the amount of precipitation was going to cause flood damage in many parts of the State.

However, there are some things Texans can do to reduce the risk of flood damages. The most important measure involves planning new development so that it isn't sited in flood-prone areas. More controversial issues include what to do with existing homes and businesses located in flood-prone areas and how to avoid repetitive losses.

Historically, Texas has relied on structural flood control projects - construction of dams, levees, channels and even drainage tunnels. While these measures have merit, recent evidence is showing that flood control dams, for example, can not be justified economically if they are built and paid for by local governments.

Evidence suggests that a mix of structural and non-structural policies (including programs that discourage development of flood-prone areas, relocating or buying out vulnerable areas and creating incentives to move out of those areas) may be the best way to control flood damages.

REFERENCES

Buffalo Bayou and Tributaries, Flood Damage Prevention Feasibility Report, U.S. Army Corps of Engineers, Galveston, TX, 1988.

Burby, Ray, Cities Under Water, Behaviorial Sciences Institute, University of Colorado, Boulder, CO, 1988.

Burka, Paul, "The Unholy Trinity," Texas Monthly, Austin, TX, July 1990.

Clean Water, North Central Texas Council of Governments, Arlington, TX, 1990.

Common Vision: Upper Trinity River Reconnaissance Report, U.S. Army Corps of Engineers, Ft. Worth, TX, 1990.

Community Rating System, Federal Emergency Management Agency, Washington, DC, 1990.

FEMA! NFIP Annual Report, Texas Water Commission, Austin, TX, 1990.

Flood Insurance: Information on the Mandatory Purchase Requirement, U.S. Government Accounting Office, Washington, DC, 1990.

Flood Insurance: Statistics on the National Flood Insurance Program, U.S. Government Accounting Office, Washington, DC, 1988.

Interagency Hazard Mitigation Report in Response to the May 2, 1990 Disaster Declaration for the State of Texas, FEMA Region 6 Interagency Hazard Mitigation Team, 1990.

Milleman, Rose, and Elsie Jones, Storm on the Horizon: The National Flood Insurance Program and America's Coasts, National Wildlife Federation, Washington, DC, 1989.

National Flood Insurance Program: Major Changes Needed if It Is to Operate Without a Federal Subsidy, U.S. Government Accounting Office, Washington, DC, 1983.

Rose, James, "The Mandatory Flood insurance Purchase Requirement," ABA Bank Compliance, Washington, DC, Autumn, 1988.

Questions and Answers on the National Flood Insurance Program, Federal Emergency Management Agency, Washington, DC, 1990.

Thomas, Frank, A Status Report on the

Nation's Floodplain Management Activity, Interagency Task Force on Floodplain Management, Knoxville, TN, 1989.

Wurbs, Ralph, "Economic Feasibility of Flood Control Improvements," Journal of Water Resources planning end Management, New York, NY, January, 1988.