The 1951 Kansas - Missouri Floods ... Have We Forgotten?

Introduction -

This report was originally written as NWS Technical Attachment 81-11 in 1981, the thirtieth anniversary of this devastating flood. The co-authors of the original report were Robert Cox, Ernest Kary, Lee Larson, Billy Olsen, and Craig Warren, all hydrologists at the Missouri Basin River Forecast Center at that time. Although most of the original report remains accurate today, Robert Cox has updated portions of the report in light of occurrences over the past twenty years. Comparisons of the 1951 flood to the events of 1993 as well as many other parenthetic remarks are examples of these revisions.

The Storms of 1951 -

Fifty years ago, the stage was being set for one of the greatest natural disasters ever to hit the Midwest. May, June and July of 1951 saw record rainfalls over most of Kansas and Missouri, resulting in record flooding on the Kansas, Osage, Neosho, Verdigris and Missouri Rivers. Twenty-eight lives were lost and damage totaled nearly 1 billion dollars. (Please note that monetary damages mentioned in this report are in 1951 dollars, unless otherwise stated. 1951 dollars can be equated to 2001 dollars using a factor of 6.83. The total damage would be $6.4 billion today.) More than 150 communities were devastated by the floods including two state capitals, Topeka and Jefferson City, as well as both Kansas Cities.

Most of Kansas and Missouri as well as large portions of Nebraska and Oklahoma had monthly precipitation totaling 200 percent of normal in May, 300 percent in June, and 400 percent in July of 1951. The June 1951 monthly average rainfall over Kansas of 9.55 inches was the greatest monthly average ever recorded. (Although in 1993 the rainfall totals in many areas exceeded those of 1951, according to the Kansas state climatologist, the 1951 record remains intact. July 1993 saw a state-wide average rainfall of 9.36 inches.)

Major stream overflows began in June 1951 and the conditions established were favorable for a devastating flood from later storms. From July I to July 8, intermittent rains continued to fall over saturated watersheds in eastern and northern Kansas. The long period of excessive rainfall climaxed with extremely heavy precipitation from July 9 to 12 with some unofficial rainfall reports indicating 17 to 19 inches for the 3 days. This July 1951 storm was the greatest of record in the lower Kansas Basin (with the possible exception of storms in June of 1844). Many locations in eastern Kansas received nearly thirty inches of rain in the spring and early summer of 1951. The magnitude of runoff into the rivers was correspondingly high. For example, the June and July 1951 flow of the Kansas River at Topeka was 3 times the flow which would normally be expected from the Kansas Basin in an entire year. The result was wide-spread flooding of immense proportions.

Severity and Extent of the 1951 Floods -

The excessive rainfall during May, June, and July 1951 resulted in frequent periods of severe flooding throughout Kansas and adjacent states during late spring and early summer. Floods in the Marais des Cygnes, Verdigris, and Neosho River Basins began in June. In some tributary basins, such as the Delaware River and the upper Blue River in Kansas, the June crests were even higher than the subsequent July crests. The Kansas River exceeded flood stages on June 9-10 and again on June 22 - July 3. The Mississippi River reached flood stage at St. Louis, Mo., on June 29 and remained above flood stage for 32 days.

Friday, July 13, 1951 still stands as the single greatest day of flood destruction in this area. On this date, the Kansas River crested at all official gaging stations from Manhattan to Bonner Springs. The Marais des Cygnes, Neosho, and Verdigris Rivers were at, or near, crests at all points in Kansas. A total of 1,074,000 acres in Kansas and 926,000 in Missouri were flooded.

Manhattan and Ft. Riley, Kansas were the first significant urban areas inundated by the Kansas River. Barracks were smashed and water stood 8 feet deep in the Manhattan business district. The crest rolled on, hitting Topeka at 6 AM on the 13th, resulting in the evacuation of 24,000 people. At Lawrence, Kansas, the same story was repeated.

In the Kansas City area, the Kansas River poured over levees protecting the Argentine district in the early hours of July 13th. By 5 AM on the 13th, the flood topped the levees protecting Armourdale causing the evacuation of 15,000 persons. Damages in the Kansas City area to homes, railroad yards, stockyards, packing plants, warehouses and manufacturing plants ultimately totaled $425 million. Major fires resulted from damaged oil tanks. Runaway barges smashed into the Hannibal Bridge adding to the confusion and difficulties. Hogs and cattle were stranded or washed from the stockyards. The American Royal building was under 15 feet of water and homes in Armourdale had water lapping at the roofs. Flood waters crept within 4 blocks of Union Station.

The Kansas River crested 18 feet over flood stage at Bonner Springs, Kansas, late on July 13th and then reached the 23rd St. bridge in Kansas City at 4 AM on July 14th. The crest then pushed into the Missouri River, resulting in a stage at

Kansas City of 46.2 feet (current gage datum) at 5 AM. This crest was 14 feet over flood stage and had a flow of 573,000 cubic feet per second (cfs), or 256 million gallons per minute, about 10 times the normal Missouri River flow. A flow of this magnitude for just 6 hours would supply the present water needs of the Kansas City metropolitan area for nearly a year. Fortunately, the Kansas was pouring flood waters into the Missouri River at a time when the Missouri had only moderate flow from upstream. The crest continued on downstream reaching Boonville, Mo. on the 17th, Jefferson City, Mo. on the 18th, Hermann, Mo. on the 19th and St. Charles, Mo. on the 20th of July, all at about 12 feet over flood stage.

Detailed surveys to determine flood losses were conducted by the U.S. Army Corps of Engineers and the National Weather Service. The greater Kansas City metropolitan area suffered the greatest monetary loss, some $425 million. Additional estimated community losses were: Salina, Ks. - $3.2 million, Ft. Riley - $7 million, Manhattan - $13 million, Topeka - $34 million, and Lawrence - $3 million. Agricultural damage was estimated at $93 million. Losses in the Marais des Cygnes / Osage basin were estimated at $30 million.

Most of the damage along the main stem of the Missouri River was confined to the reach between Kansas City and St. Louis. Total damages of $107 million were estimated, of which $80 million was agricultural and $27 million non-agricultural.

In all, the floods of June - July 1951 are estimated to have caused property damage totaling $935,000,000 (6.4 billion in today's dollars). 500,000 people, 370,000 in Kansas and 130,000 in Missouri, were displaced from their homes and 150-200 cities and towns were damaged. Fortunately, the loss of life was relatively small with a total of 28 persons listed as losing their lives as a direct result of the floods.

Comparison of 1951 Flood to 1993 -

Today, when most of us think of the "great flood", our minds harken back to the events of eight years ago which affected so much of the Midwest. However, for those residents of the Kansas, Neosho, Verdigris, and Osage basins who are old enough to remember, the 1951 flood is undoubtedly what comes to mind. In fact, most of the record flood levels achieved in these basins during July 1951 have still not been exceeded. Even on the Missouri River at Kansas City, the maximum streamflow of record remains 573,000 cfs on July 14, 1951. However, the crest stage of 46.2 ft reached in 1951 was exceeded by a crest of 48.9 ft on July 27, 1993 (due, at least in part, to higher levees and floodwalls constricting the flow-way). Likewise, the 1951 crests were exceeded by those of 1993 for other locations between Kansas City and St. Louis by 2.5 to 4.5 feet. The following table compares the maximum levels reached during these two floods for several locations in the Kansas and Missouri basins.

Location	1951 Flood	1993 Flood
Saline River		
Tescott, Ks	30.06 ft, 7/13	30.14 ft, 7/23
Smoky Hill River		
Abilene, Ks	34.00 ft, 7/14	32.10 ft, 7/22
Enterprise, Ks	38.96 ft, 7/14	33.95 ft, 7/22
Kansas River		
Ft. Riley, Ks	34.50 ft, 7/13	27.93 ft, 7/26
Manhattan, Ks	33.39 ft, 7/13	29.92 ft, 7/25
Topeka, Ks	40.80 ft, 7/13	34.97 ft, 7/24
Lawrence, Ks	29.90 ft, 7/13	26.80 ft, 7/27
Kansas City, Ks (23rd Street)	61.30 ft, 7/14	54.80 ft, 7/28
Missouri River		
Kansas City, Mo	46.2' (573,000 cfs), 7/14	48.9' (541,000 cfs), 7/27
Waverly, Mo	28.2' (549,000 cfs), 7/14	31.2 '(633,000 cfs), 7/27
Boonville, Mo	32.8' (550,000 cfs), 7/17	37.1' (755,000 cfs), 7/29
Jefferson City, Mo	34.20 ft, 7/18	38.30 ft, 7/31
Hermann, Mo	33.3' (618,000 cfs), 7/19	37.0' (750,000 cfs), 7/31
St. Charles, Mo	37.30 ft, 7/20	40.04 ft, 8/2

Flood Control Measures Since the 1951 Flood -

In July 1951, five federal flood control dams were operating in the Kansas River basin: Bonny dam in Colorado, Enders and Medicine Creek dams in Nebraska, and Cedar Bluff and Kanopolis dams in Kansas. These dams controlled approximately 11,500 square miles of the total 60,060 square-mile Kansas River basin. Together, they offered approximately 800,000 acre-feet of flood control storage. As a comparison, the U.S. Geological Survey estimated that 5,300,000 acre-feet of water flowed past the Bonner Springs, Kansas gage during the period July 10-20, 1951. These dams were relatively ineffective during the 1951 flood due to the location of the storm center in the downstream portion of the basin. Kanopolis dam, which was located the nearest to the storm center, provided temporary storage for only 97,000 acre-feet of runoff from the July 9-12 rains.

Although only five major dams existed in the Kansas basin in 1951, many others had been planned by both the Corps of Engineers and the Bureau of Reclamation. Since the Flood Control Act of 1944, these two agencies had been authorized by Congress to proceed with the planning of a comprehensive water resources development plan for the Missouri River basin known as the Pick-Sloan plan. Among other measures, this plan provided for the construction of reservoirs on the mainstem Missouri River upstream of Sioux City, Iowa as well as major tributaries to the lower Missouri River, including the Kansas, Marais des Cygnes / Osage, and Grand River basins. Construction of only a few of these projects had been initiated by 1951.

Public support for flood protection generally reaches a peak shortly after a flood occurs. The more devastating the flood, the more staunch the support. Such was the case in 1951. No sooner had the waters of the Kansas River begun to recede from Argentine, Armourdale, and the Central Industrial District of Kansas City than proponents of flood control began their efforts. Local support grew and federal funds became available. Today, flows in the lower Kansas River basin are regulated by eighteen reservoirs. Together, they provide 6,750,000 acre-feet of flood control storage for storm runoff from approximately 50,900 square miles. It has been estimated that these structures could have lowered the 195l flood crest by about 5 feet at Kansas City. Approximately 9200 square miles of the lower Smoky Hill and Kansas River basins remain uncontrolled.

The construction of flood control dams since 1951 has not been confined to the Kansas River basin. In 1951, the Osage basin upstream of Lake of the Ozarks was completely unprotected by upstream reservoirs. Since then, Pomona, Melvern, Stockton, Pomme de Terre, Truman, and Hillsdale dams have been constructed by the Corps of Engineers to help reduce the flood potential of the Marais des Cygnes / Osage River basin. These control 7900 square miles of the basin and provide for the temporary storage of 5,700,000 acre-feet of storm runoff. The Verdigris River basin in southern Kansas was offered some degree of flood protection in 1951 by Fall River dam. Since that time, the basin has seen the construction of Toronto, Elk City, and Big Hill dams. Three dams, Marion, Council Grove, and John Redmond, have also been completed in the upper Neosho River basin since 1951.

Although the upper Missouri River basin did not contribute appreciably to the flooding at Kansas City in 1951, the 370,000 square-mile drainage area between Ft. Peck dam in Montana and Kansas City obviously has the potential to produce floods of even greater magnitude than 1951. Five mainstem dams proposed in the Flood Control Act of 1944 were constructed throughout the Dakotas during the period from 1951 to 1964 to provide flow regulation for flood control and navigation. Along with Ft. Peck dam, they control a drainage area of approximately 280,000 square miles and provide a flood control storage of 16,000,000 acre-feet, more than twice the volume of water that flowed past Kansas City during the 1951 flood.

Flood control measures instituted since 1951 have not all taken the form of dams. Local protection projects in the form of levees, floodwalls, and channel improvement have also been constructed. These have included both private and federally-funded levees in the Missouri River floodplain offering flood protection to urban as well as agricultural areas. Many of the communities which were devastated in 1951, including Salina, Manhattan, Topeka, Lawrence, Ottawa, Osawatomie, and Kansas City, have seen either the construction of new levees and floodwalls or the raising of existing levees. For the most part, these projects have been designed by the Corps of Engineers to provide three feet of freeboard above the high water profile from a flood of even greater magnitude than the 1951 flood. The assumption was made, however, that flood flows would be regulated by all existing reservoirs in the Kansas River basin as well as three additional reservoirs which have not been constructed.

According to the Corps of Engineers, if the rainfall that led to the 1951 flood were to duplicate itself in 2001, the upstream reservoirs in existence today would reduce the peak discharge at Kansas City from 510,000 c.f.s. that occurred in 1951 to 360,000 c.f.s. The levees and floodwalls protecting the Argentine, Armourdale, Fairfax, and Central Industrial districts of Kansas City have also been raised several feet since 1951 and are designed to pass a discharge of 390,000 c.f.s. with 3 feet of freeboard. Theoretically, a discharge of 445,000 c.f.s. would be required to overtop the levees. However, the current overtopping discharge of the Kansas River levees in Kansas City was equaled by the 1951 flood on the Neosho River at Iola, Kansas, with a drainage area of only 3,818 square miles. The uncontrolled drainage area of the lower Kansas basin today is 9,191 square miles. Can it be assumed then that Kansas City is totally safe from the devastation which occurred in 1951?

Could It Happen Again ?

In general, a flood of the magnitude of the 1951 flood could occur again in the two-state area of Kansas and Missouri. There are many different factors related to flood events, however, which one must consider when discussing the possibility of a flood equal to 1951 reoccurring. These factors could include loss of lives, monetary damages and areal extent of damage, flood producing storms, antecedent hydrometeorological conditions, discharge and stage at the point of interest and maximum probable floods.

One need only go back to September 1977 when 25 persons were killed in the Kansas City flood in order to nearly equal the 28 lives lost in the 1951 flood. Other recent deadly floods in the United States killed 76 in Johnstown, Pa. in 1977, 139 in Big Thompson Canyon, Co. in 1976, and 236 in Rapid City, S.D. in 1972. The “Great Flood of 1993", although affecting an even larger geographic area, resulted in 50 flood-related deaths. Thus, it is quite apparent that the death figure from the 1951 floods can and have been exceeded frequently through the years.

In terms of monetary losses, the 1951 flood, with damages of nearly a billion dollars (6.4 billion dollars today), remains one of the most destructive ever to hit this country. The 1951 damage totals in Kansas City were very high due to the large areal extent of the flooding and because heavy industry in the Kansas-Missouri River floodplains was hit very hard. Flood damage in Kansas City in 1951 was estimated at about $500 million or about 3 billion in today's dollars. As a frame of reference, the Kansas City floods of 1977 caused about $300 million in damages (about 1/10 the monetary damages of the 1951 flood) in a relatively small and localized area.

As far as the July 1951 storms are concerned, several other large storms in the area have produced even greater rainfall totals over an area of equal size. The 1903 storm, centered in the Kansas basin, produced nearly identical rainfall amounts but resulted in only about one-half the discharge at the mouth of the Kansas River. The May 1943 storm, centered in eastern Oklahoma, produced an average rainfall amount of approximately 11 inches over a 20,000 square mile area. This is 1.5 inches more than the 1951 Kansas storm over an equal area. As mentioned previously, rainfall totals in 1993 actually exceeded 1951 amounts at many locations. Fortunately, however, much of the heaviest rainfall occurred upstream of flood control reservoirs and not in the downstream, uncontrolled portion of the Kansas basin. Storms in 1844 were so large that they produced floods which exceeded 1951 levels on the Kansas River and on the Missouri River below Kansas City. Clearly storms comparable to those of 1951 have occurred in the past and will occur again.

Why did the 1903 storm only produce half the flow of the 1951 storm at the mouth of the Kansas River with basically the same rainfall amounts? The answer is the longer duration of the 1903 storm and drier initial soil conditions allowed more of the precipitation to "soak in" thus reducing streamflows. As previously mentioned, the months prior to the 1951 flood were very wet in Missouri and Kansas and significant floods took place in the Kansas basin in June. Therefore, streamflow was, in general, quite, high before the cloud bursts of 9-12 July and soils were wet. The result was high runoff and flows during the 1951 storm. This points out the importance of soil conditions prior to a storm in determining the magnitude of flooding.

Man-made changes to a river basin can increase flood levels and resulting damages. Urbanization increases runoff and the resulting flow in the river channel. Levees and floodwalls prevent river overflows from spreading across the natural flood plain. This results in higher stages for a given flow in the channel. For example, in 1973, higher levels of flooding occurred on the Missouri River at several locations downstream from Kansas City than occurred in 1951, however, the actual flow in the channel was only about one-half of that in 1951. In addition, development such as industry or housing on a flood plain increases monetary damages when flooding does occur. These types of changes are occurring continuously and make anticipation of future flood damage potential even more difficult.

Not only do examples in Kansas and Missouri indicate greater floods than those which occurred in 1951 at Kansas City are possible, but other observed floods in the United States indicate this possibility also. Studies of other floods in the United States show that flows from an area equal to the current uncontrolled drainage of the Kansas River could equal one million cubic feet per second (twice the 1951 flow) at the mouth of the Kansas River. Many of these other floods, however, occurred in areas of the United States which have meteorological and hydrological conditions different from the Central United States.

An interesting concept to consider is the idea of a maximum probable flood. The maximum probable flood is defined in hydrometeorology as the estimated flood that may be expected from the most severe combination of critical meteorological and hydrological conditions considered reasonably probable of occurring in an area. In the case of Kansas City, the maximum probable flood could be thought of as being about 2.5 times the current design discharge for the levee project on the Kansas River. A precise percent chance of occurrence in any given year cannot be computed for these extremely rare events. As an example, the 1977 flood in Kansas City was produced by rainfall averaging 12 to 14 inches in 24 hours around the Brush Creek basin. The maximum probable precipitation for the same area is approximately 25 inches in only 6 hours, an almost unimaginable amount of water!

We have seen in recent years that many more lives can be lost in floods, especially in metropolitan areas, than were lost in the 1951 floods. It is also quite apparent that storms equaling or exceeding those of 1951 have not only occurred in the past but will occur again in the future. Also, when heavy industrial areas such as those protected by levees are damaged, monetary losses could easily equal those of 1951. But what events would be necessary today for widespread flood damages to occur in the Kansas basin such as occurred in 1951?

First, several weeks or months of much above normal precipitation would be necessary to saturate the soil, increase groundwater levels, produce high streamflows throughout the basin, raise Corps of Engineers' reservoirs well into flood control pools and elevate Bureau of Reclamation reservoirs to high levels. At the same time, major storms in Nebraska and Iowa could raise the Missouri River flow significantly at Kansas City, perhaps even to flood stage or above. The area would then be set for a devastating three to five day super-storm.

One possible storm type would be that associated with a slow moving or stationary east-west oriented frontal system located across the central portion of the Kansas basin. Interaction of a large polar air mass to the north and warm moisture-laden air from the Gulf of Mexico for several days would be necessary to produce the required large rainfall amounts averaging 15 inches or more over the entire Kansas basin. The center of heaviest precipitation would have to occur in the uncontrolled portion of the Kansas basin located roughly near a line from Salina to Kansas City. Maximum rainfall totals in this area would probably need to be in the 20-inches-plus range for the three to five day storm. While precipitation totals of this magnitude are not likely, they are theoretically possible. (This scenario is very similar to the occurrences of 1993, except that the “super-storm” producing over 20 inches of rainfall in the downstream, uncontrolled portion of the Kansas basin did not materialize.)

Yes, there could be a repeat of the 1951 flood destruction in the Kansas basin, but the chances are quite small. The last 50 years have seen a major effort to prevent destruction from floods of the 1951 type from reoccurring. Some 13 major upstream reservoirs have been constructed in the Kansas basin alone. When dealing with nature, however, it is not possible to say "it will never happen again."

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