# United States Flood Loss Report - Water Year 2011

## Executive Summary

Direct flood damages during Water Year 2011 (October 1st 2010-September 30th 2011) totaled $8.41 billion. This was 108% of the thirty year average (1981 - 2010) of $7.82 billion (adjusted to 2011 inflation). There were 108 flood-related deaths (118% of the 30 year average of 94*).* Of these fatalities, 61 were vehicle related incidents, and 71 were attributed to flash flood events.

2011 was a year of record-breaking, prolonged floods along some of the nation's largest rivers, the Missouri, Ohio and Mississippi. Heavy precipitation from the previous fall and summer across the Northern Plains left soils saturated and streams running high before the winter freeze. Once frozen soils locked moisture in place, a snowpack nearly double the average began to accumulate, setting up the north central U.S. for unavoidable spring snowmelt flooding. By mid-April, several heavy rain producing systems stalled over the Ohio River and central Mississippi River Valleys. Record rainfall fell across a broad expanse from Tulsa, Oklahoma to Cincinnati, Ohio from April 15 to May 6 amplifying the snowmelt-induced flood wave heading southward from the Upper Mississippi River Basin. Flash floods associated with these storms caused 24 deaths across Oklahoma, Missouri, Arkansas, Louisiana and Tennessee in April and May. The Ohio River and the Lower Mississippi River experienced record flooding levels (last seen in 1937 and 1927, respectively) that lasted for well over a month. These well anticipated floods caused a total of $3.4 billion in direct damages, nearly half of the annual total.

Two tropical systems impacted densely populated portions of the Mid-Atlantic and Northeastern U.S., Hurricane Irene and the remnants of Tropical Storm Lee. These events, happening just over a week apart in late August and early September, combined to produce 37 freshwater flood fatalities and at least $3.9 billion in direct freshwater flood damages from Virginia to Vermont.

*See below for detailed summaries and associated flood losses for the most significant events during Water Year 2011. Additionally, a table of all flood losses by state is provided.*

## NWS Role in Flood Loss Statistics

There is no one agency in the United States with specific responsibility for collecting and evaluating detailed flood loss information. The National Weather Service (NWS), through its many field offices, provides loss estimates for significant flooding events. However, this task is ancillary to the primary focus of the NWS, predicting events that lead to death and damage. Therefore, the

estimates provided here should only be considered approximations[1].

This report provides a summary of *direct flood damages*, which account for damage to a) private property, including structural damage and lost agriculture and b) public infrastructure and facilities. Flood loss estimates reported by other entities, such as media, insurance, or other governmental agencies often include additional *indirect* flood-related costs such as a) mitigation costs (e.g., sandbagging, temporary levees, and temporary shelters) and b) projected estimates of economic loss (e.g., disruption to planting and harvesting, lost wages, disruption to transportation, interruption to commerce due to closed facilities, reduction in tourism). Typically, flood loss estimates which include indirect costs are much larger than the direct flood damage estimates reported here.

It is also important to note this report concerns itself only with fresh water flooding, and does not account for coastal flooding related to cyclone related storm surge. An example of this distinction is Hurricane Katrina in 2005 where the majority of flood deaths were caused by storm surge, thus impacts were categorized separately from freshwater flooding (caused by rain and/or snow melt, dam or levee failures, and ice jams). Storm surge death and damages are not included in this report.

## Detailed Major Events Summary

1. **Ohio, Mississippi and Missouri Basin Floods: April 2011 to August 2011**
   Heavy late summer and autumn precipitation across the Northern Plains of the United States left soils saturated and streams running high before the winter freeze-up. Winter brought above average snows in the north with 150 to 200 percent above normal snowfall across the Upper Mississippi River Valley (Minnesota, Wisconsin and Iowa). Melting of the substantial winter snowpack was slow and protracted, and led to very high, sustained river flows throughout the Mississippi River and Missouri Basins. Record spring and summer rainfalls on top of snow and/or wet soils caused major floods through long stretches of the nation's largest rivers, the Missouri, Ohio and Mississippi Rivers.

   The slow nature of the melt and the enormous areal extent of snow covered, saturated ground yielded multiple flood waves on each major river. The first waves began in early April, along the Upper Mississippi near Davenport Iowa, and the James River in South Dakota. Impacts were initially relatively minor. More importantly, the slow ablation of the expansive snowpack enabled the upper reaches of the Mississippi and Missouri Rivers to provide a continuous

[1] Pielke, Jr., R.A., M.W. Downton, and J.Z. Barnard Miller, 2002: *Flood Damage in the United States, 1926-2000: A Reanalysis of National Weather Service Estimates*. Boulder, CO: UCAR.

supply of flood waters to points downstream, throughout the spring and into summer.

## 1.1. Lower Ohio/Mississippi Basins: April – May, 2011

While the northern plains thawed in mid-April, the southern plains rapidly transitioned from a dry winter to a very wet spring. By late April, repeated rounds of intense storms laden with Gulf moisture pounded the central-southern plains, Lower Mississippi and Ohio River Valleys. Ten to 20-plus inches of rain (400-600% of normal in some areas) fell across a broad expanse from Tulsa, Oklahoma to Cincinnati, Ohio from April 15 to May 6. Flash floods associated with these storms affected areas across Oklahoma, Missouri, Arkansas, Louisiana and Tennessee. Adding to the complexity of this situation, snowmelt flood waters from thousands of miles to the north flowed down the Mississippi River. This inhibited local flood waters of the Lower Mississippi tributaries from efficiently draining, keeping backwaters, bayous and tributaries in flood stage well into May, and even late June in some locations. The Ohio River and the Lower Mississippi River experienced record flooding levels (last seen in 1937 and 1927, respectively) that lasted for well over a month.

### 1.1.1. Immediate Impacts: (24 fatalities, $0.4Billion)

April 23rd through the 27th was the deadliest single week of the 2011 spring flood season. 12 people were killed by flash floods from the Ozark Mountains of southern Missouri, across the Mississippi Valley into Tennessee. All 12 fatalities were vehicle related, including 5 from drivers who chose to drive around barricaded road closures. Just a few days later, three more people died as up to 12 inches of additional rain fell from April 30th to May 2nd in Central Arkansas, including the Little Rock area. As this thunderstorm complex slowly moved eastward, 6 more people died in Eastern Arkansas, 3 in Ohio, Louisiana and Tennessee. On May 23rd, flash flooding associated with additional heavy rain producing thunderstorms claimed 4 lives. These fatalities were associated with a single vehicle related event in northwestern Arkansas.

All told, the flash floods associated with these storms, claimed 24 lives and caused $400 million in direct damages (not including the mainstem Mississippi River flood impacts detailed below) during April and May across the Deep South. Twenty of these fatalities were vehicle related, including at least 6 motorists who ignored road closures and drove around barricades. The socioeconomic impacts in Arkansas were worse than any other state, accounting for 17 of the 24 deaths, and 75% of the property/crop damage.

### 1.1.2. Mainstem River Impacts: (1 fatality, $3.4Billion)

As water drained into the lower Ohio and Mississippi Rivers, their

channels were full from a wet spring and lacked the capacity to handle additional runoff. The collective capacity of these river systems was so stressed it necessitated, for the first time in history, that the total watershed system be operated in a synchronized manner to manage the highest level of water it had ever recorded. This magnitude of this event was just shy of the Project Design Flood used to design and execute flood protection in the Mississippi River Valley. Even with 3 out of 4 USACE floodways employed simultaneously to reduce flood levels and mitigate damages, the Ohio River and the Lower Mississippi River experienced record flooding levels from Cairo, Illinois to the Gulf of Mexico, exceeding the major floods of 1937, 1973, and 2008 with significant impacts along the way.

**Kentucky, Illinois, and Missouri:** On May 3, 2011, the USACE executed the water control plan at the Birds Point-New Madrid Floodway. Operation of the floodway is part of the flood risk management plan for the Lower Mississippi River to reduce flood stages and ease pressure on the entire system during significant flood events. The opening of the levee displaced approximately 200 residents in Mississippi and New Madrid Counties, Missouri, and flooded approximately 130,000 acres of farmland.

Damage to public infrastructure, private property, crop production, and commerce upstream of the New Madrid Floodway was approximately $360 million. This estimate includes impacts to surrounding portions of the Mississippi and Ohio Rivers upstream of the floodway, from Paducah Kentucky to New Madrid, MO.

**Tennessee**: The Memphis area suffered the largest direct damages with $2 billion in Shelby County (Memphis) alone. In downtown Memphis, the Harbor Town neighborhood was evacuated of its 5,200 residents as the Mississippi River rose to record levels.

**Mississippi:** The flood crest moved down the Mississippi River between May 15 and May 21, 2011, causing slightly over $1 billion in direct damages. Most of the destruction was in Tunica County, the far northwestern corner of Mississippi just downstream from Memphis. Nine casinos on stationary barges in Tunica County were closed during the peak of the flood. On May 15, the Harrah's Tunica reported nearly 6 feet of water inside the hotel. In Wilkinson County, all communities north and west of Highway 24 were inundated and evacuated. Record flooding occurred in the Fort Adams area; hundreds of properties and several roads were impacted and required evacuation of almost 1000 people. Even with temporary levees erected in and around Vicksburg, more than 2600 residences,

businesses, and other structures were impacted by flood waters.

**Louisiana:** For the first time since 1973, the Morganza Spillway was opened to avert a levee breach and subsequent flooding of Baton Rouge and New Orleans. The opening of this spillway flooded approximately 4,600 square miles of rural Louisiana downstream from the spillway, along and near the Atchafalaya River. There were significant economic impacts to commerce along the lower reaches of the Mississippi River. Lock closures and loading issues impacted barge traffic. High river levels resulted in low-clearance for ships attempting travel under bridges and power lines, and additional fuel was needed for increased power for navigation. Impacts on parishes included approximately 2500 evacuations and many road closures.

Overall losses from floods along the Lower Ohio/Mississippi River were estimated at $3.4 billion. Only one fatality was directly caused by the river floods.

### 1.2. Missouri and Souris River Basins: May – August 2011 (5 fatalities, $0.2 Billion)

The Missouri and Souris River Basins were primed by a wet fall and record snowpack over much of the northern Rockies and Northern Plains. A cool spring held the snowpack in place later than usual, and a fairly rapid melt off of the snow eventually coincided with record-setting rains in May and early June. A series of storm systems during the month of May brought 300-400 percent of average annual precipitation to the headwater areas of Montana, North Dakota and southern Canada, and heavy snowfall to the adjacent Rocky Mountains. Runoff from the record snowpack and extreme precipitation events produced an unprecedented volume of water moving through the Missouri River Basin system. All 6 USACE reservoirs along the Missouri River were at record high levels and sustained record releases from mid-June into early August. Of the 38 National Weather Service river forecast locations along the combined 2977 miles of the mainstem Missouri and Souris Rivers, 25 experienced major flooding, with 15 locations experiencing record flooding. The Missouri River at Pierre, SD was above flood stage from May 24$^{th}$ through September 7$^{th}$, 2011.

States up and down the Missouri River, including Montana, North Dakota, South Dakota, Nebraska, Iowa, Kansas and Missouri, were impacted by this flood event. The stretch of the Missouri river between Sioux City, Iowa and Omaha, Nebraska, incurred the greatest property damage and crop loss. In total, the floods of Missouri River Basin caused approximately $85 million in direct damages, claimed 5 lives and led FEMA to issue disaster declarations in each state along the Missouri River. Two of these flood deaths were vehicle related and occurred

directly on or near the main-stem Missouri River.

The Souris River in North Dakota was flooding at approximately the same time as the surrounding Missouri River watershed. On June 22nd, an estimated 11,000 people were forced to evacuate Minot, North Dakota due to the record high water level of the Souris River, where 4,000 homes were flooded. Numerous levees were breached along the Souris River, flooding thousands of acres of farmland and damaging transportation infrastructure. Damage was estimated at approximately $153 million.

## 2. Tropical Storm Flooding

Two tropical systems impacted densely populated portions of the Mid-Atlantic and Northeastern U.S., Hurricane Irene and the remnants of Tropical Storm Lee. These events happened just over a week apart in late August and Early September.

### 2.1. Hurricane Irene August 27-28, 2011 (21 fatalities, $2.3 Billion)

Hurricane Irene made landfall near Cape Lookout, North Carolina on August 27th as a category 1 hurricane, moved up the Outer and Delmarva Peninsula, making another landfall near Atlantic City, New Jersey on August 28th. As Irene's remnants moved north catastrophic floods occurred in New York and New England, especially in central and southern Vermont. Widespread rainfall amounts of 4-7 inches occurred across much of southern and central Vermont.

These rains caused devastating flash flooding across many mountain valleys with some record breaking flood stages on larger rivers. This flood event destroyed or damaged nearly 2400 roads, 800 homes and businesses, 300 bridges, and railroad tracks in a half dozen locations in southern Vermont. Three towns in the Catskill Mountains in New York were uninhabitable after the floods.

In total, the devastating freshwater floods of Hurricane Irene caused $2.3 billion in direct damages and 21 fatalities across the Northeast; 9 in New York, 5 in New Jersey, 3 in Vermont, 2 in Pennsylvania, and 2 in Delaware.

### 2.2. Tropical Storm Lee September 1-5, 2011 (16 fatalities, $1.6 Billion)

Tropical Storm Lee formed over the Gulf of Mexico on September 1 and produced of 10-15 inches of rain in Louisiana, Mississippi and Alabama. As Lee's remnants continued north over the Mid-Atlantic region, its interaction with continental weather systems produced 10-20 inches of rainfall over densely populated areas from eastern Virginia to southern New England. Over the Mid-Atlantic States, record rainfall fell over areas that had already experienced a wet summer, including significant rains from Hurricane Irene less than two weeks prior.

This led to major flooding along the Susquehanna River and its tributaries, which in some areas broke high-water records set nearly 40 years earlier in the aftermath of Hurricane Agnes (1972). In western New York, water levels topped levees along the river, which inundated several cities including Waverly, Owego, Vestal, Endicott, Johnson City, and downtown Binghamton. Numerous roads were closed in the area and 20,000 people were ordered to evacuate Binghamton. In Pennsylvania, the forecast of flooding led to the evacuation of about 100,000 people, including 10,000 people and the Governor's residence in the downtown Harrisburg area. The most significant flooding occurred in towns along the Susquehanna River. In Dauphin and Lebanon Counties in the greater Harrisburg area, nearly 5,000 homes were damaged or destroyed. Numerous roads and 18 bridges were also damaged in Pennsylvania.

In total, freshwater flooding related to the remnants of Lee were responsible for $1.4 billion in direct damages and 16 deaths; 10 in Pennsylvania, 4 in Virginia, one in Maryland, and one in Georgia. Nearly all of these deaths occurred when individuals tried to cross flooded roadways in vehicles or were swept away in flood waters.

## 3. Other Significant Flood Loss Events

### 3.1. Southern California and Desert Southwest Floods December 21-31, 2010 (2 fatalities, $0.2 billion)

A series of storms fueled by a tropical moisture tap pounded Southern California, the Mojave Desert and the Great Basin during the last 10 days of 2010. Extremely heavy snow and widespread flooding caused numerous vehicle accidents, swift water rescues, beach closures and extensive damage to property and infrastructure. President Obama proclaimed a Federal disaster declaration for 10 counties in California. All told, the Southern California and Desert Southwest floods of December 2010 killed two (both in Southern California), and caused approximate $207 million in direct damages.

### 3.2. Midwest Flash Floods June 17-20, 2011 (3 fatalities, $0.2 billion)

A series of thunderstorms with heavy rainfall across portions of Illinois, Kentucky and Tennessee between June 17th and June 20th produced widespread flash flooding. Nearly 2,500 homes, more than 100 businesses and a state prison with more than 1,600 inmates sustained flash flood damage. All told, these flash floods caused $175 million in direct damages and three fatalities; one fatality in Central Illinois, one in Kentucky and one in Tennessee.

### 3.3. Dubuque, Iowa (and Lansing, Michigan) Flash Floods July 27-28th, 2011 (3 fatalities)

Thunderstorms formed along a nearly stationary front from northeastern

Iowa across northern Illinois/southern Wisconsin to southern Michigan resulting in flash flooding in hardest hit areas (Dubuque, Iowa, and Lansing, Michigan). Record-setting rainfall totals of 7 to 15 inches resulted in flash flooding of much of the area, including 13.45 inches near Dubuque, Iowa overnight, July 27-28. These rains flooded numerous streets in East Dubuque, and caused sink holes to form as well as buckling of the road rending them impassible. In total, 3 fatalities and at least $48 million in direct damages were caused by these storms.

## FLOOD DEATHS AND DIRECT DAMAGES BY STATE

Water Year 2011

| State | Damages (whole numbers) | Fatalities |
|---|---|---|
| Alaska | $ 1,500,000 | 0 |
| Alabama | $ 652,000 | 0 |
| Arkansas | $ 296,554,000 | 18 |
| American Samoa | 0 | 0 |
| Arizona | $ 9,595,100 | 1 |
| California | $ 199,792,000 | 3 |
| Colorado | $ 2,232,500 | 0 |
| Connecticut | $ 9,518,000 | 1 |
| District of Columbia | 0 | 0 |
| Delaware | $ 600,000 | 2 |
| Florida | $ 7,000 | 0 |
| Georgia | $ 145,000 | 0 |
| Guam | $ 100,000 | 0 |
| Hawaii | 0 | 1 |
| Iowa | $ 59,722,000 | 0 |
| Idaho | $ 4,120,500 | 0 |
| Illinois | $ 216,122,000 | 4 |
| Indiana | $ 6,521,500 | 0 |
| Kansas | $ 13,897,000 | 0 |
| Kentucky | $ 49,471,000 | 6 |
| Louisiana | $ 28,726,700 | 2 |
| Massachusetts | $ 24,630,000 | 0 |
| Maryland | $ 2,855,000 | 1 |
| Maine | $ 3,393,000 | 0 |
| Michigan | $ 10,619,000 | 0 |
| Minnesota | $ 2,848,500 | 1 |
| Missouri | $ 345,865,000 | 3 |
| Mississippi | $ 1,029,623,000 | 2 |
| Montana | $ 20,260,000 | 3 |
| North Carolina | $ 7,643,000 | 2 |
| North Dakota | $ 158,921,500 | 0 |
| Nebraska | $ 24,739,000 | 0 |
| New Hampshire | $ 26,172,000 | 0 |
| New Jersey | $ 807,895,000 | 6 |
| New Mexico | $ 17,080,600 | 0 |
| Nevada | $ 4,593,100 | 0 |

| | | |
|---|---|---|
| New York | $ 1,178,404,000 | 11 |
| Ohio | $ 44,937,500 | 2 |
| Oklahoma | $ 250,000 | 0 |
| Oregon | $ 20,852,000 | 0 |
| Pennsylvania | $ 343,648,500 | 17 |
| Puerto Rico | $ 1,385,000 | 1 |
| Rhode Island | $ 30,000 | 0 |
| South Carolina | $ 343,000 | 0 |
| South Dakota | $ 10,020,000 | 2 |
| Tennessee | $ 2,012,317,000 | 2 |
| Texas | $ 975,000 | 0 |
| Utah | $ 24,010,000 | 1 |
| Virginia | $ 1,768,500 | 6 |
| Virgin Islands | $ 1,400,000 | 0 |
| Vermont | $ 1,360,500,000 | 4 |
| Washington | $ 14,721,000 | 0 |
| Wisconsin | $ 553,500 | 1 |
| West Virginia | $ 3,479,000 | 1 |
| Wyoming | $ 4,461,500 | 4 |
| **TOTAL** | **$ 8,410,469,500** | **108** |