Floods

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FLOODS

Throughout history, natural disasters have caused death, suffering and destruction. In today's world, disasters may destroy roads, telephone lines, transportation and communication links, disrupt utilities and energy supplies, and undermine the industrial and economic base of the community or region. Natural disasters are unique in that each affected region of the world has different social, environmental and health conditions. The average economic toll from natural hazards in the United States reaches $52 billion a year, about one-third of worldwide costs.[1]

Recent History of Natural Disasters in the United States

Each year in the U.S., natural disasters cause hundreds of deaths and cost billions of dollars. Property damage events double or triple each decade. Over 75% of declared Federal disasters are flood-related. Floods cause an average of 140 deaths and cost $6 billion annually.[2] Damage to infrastructure results in high losses due to disruption of economic activity. Urbanization and coastal development lead to increased vulnerability. Climate changes also affect the intensity and frequency of floods. Floods were the main natural disaster in the United States in terms of lives lost and property damage during the 20th century.

Floods in the United States

A review of significant floods of the last century found that 20 of the 32 large flood events (63%) were regional floods occurring in areas across the nation. Excessive rainfall was the prime reason that led to 8,603 known deaths with an approximate cost of $46,821 billion. Storm surge flooding from hurricanes caused the most deaths (6,753, 78%) while regional flooding resulted in higher costs. Floods can occur at any time of year, in any part of the country, and at any time of day or night. Floods can affect a neighborhood, an entire river basin, or multiple states; floods have no state or regional boundaries. Hurricanes are usually accompanied by inland flooding. Basically, floods result from accumulation of too much water in too little time in a specific area. They are unique in that entire regions or areas downstream may be affected by the combination of excess waters, high winds, and intense low pressure systems.

Floods are also part of the natural cycle of every river. As floods become larger and spread farther, flood waters slow and deposit sediment on the floodplain, creating valuable farmland over the years.[3] Flood currents have great destructive power, demolishing buildings and undermining bridge foundations leading to collapse. Most lives are lost when people are swept away by flood currents, while most property damage results from inundation by sediment-laden water.

A major goal of the U.S. Geological Survey (USGS) is to reduce exposure of the people and areas at risk of natural hazards. The USGS measures floods and provides stream flow data through an extensive network nationwide. Stream gauging stations, some of which have operated since before 1900, provide data on flood heights and discharges, effective management of water supply and water quality methods, protection of aquatic habitat, recreation, and water resources research. Measurements of the discharge are graphed with water stage; identification and measurement of high water marks from floods help in mapping inundated areas and assist the Federal Emergency Management Agency (FEMA) to determine flood insurance rates. Areas of flood risk are assessed by records of river flow, stem tides and rainfall, and floodplain topographic surveys. A floodplain is a plain bordering a river or stream that is normally dry but covered with water during a flood. Floodplain mapping examines the size of the water shed (the region draining into a river, river system, or body of water), dimensions of the topography, and the

soil. Floodplain management involves flood hazard mitigation and flood preparedness, warning, recovery, including hydrologic (properties, distribution, and effects of water in the atmosphere, earth's surface, and in soil and rocks) and emergency response. Flood types vary according to topography, soil, climate, environment, and meteorological conditions.

Types of Floods (* More likely to occur in Oklahoma) [4]

***Regional Floods**

- Associated with slow-moving, low pressure/frontal storm system.
- Spring rains and melting snow fill river basins with too much water too quickly.
- Ground may be frozen reducing infiltration into soil, increasing runoff.
- When soil is saturated, additional rain runs off into streams and rivers exceed capacity.
- Continued wet meteorological patterns are usually responsible for large regional floods.

***Flash Floods**

- Mostly caused by slow moving thunderstorms or consecutive storms and can occur within several seconds to several hours with little warning and are life threatening.
- Can produce rapid rises in water levels and have devastating flow velocities.
- Contributory factors include rainfall intensity and duration, surface conditions, topography and slope of receiving basin.
- Susceptibility higher in urban areas due to surface area composed of streets, roofs, and parking lots, and mountainous areas due to steep topography with runoff into narrow canyons. Steep stream slopes result in floods moving downstream too fast to allow escape.
- Floodwaves 30-feet high may occur miles from the rainfall area, even in desert arroyos.
- May have a dangerous wall of roaring water that carries rocks, mud, and other debris that can sweep away most things in its path.
- Oklahoma has clay soils and intense rainfalls, increasing the risk of flash floods.

Ice-Jam Floods

- Occur on frozen rivers. A rise in stream-stage leads to ice flows that pile upon obstructions creating a dam over which water continues to flow, overflowing channel banks.
- The flood takes on characteristics of a flash flood when the dam fails with the danger of ice flows inflicting damage on structures.

Storm-Surge Floods

- Occur when water is pushed onto dry land by onshore winds.
- Created by intense, low pressure systems and hurricanes; pounding waves cause hazardous flood currents.
- Friction between water and moving air create drag that can pile water 20 feet and higher.
- Danger is much higher when surge occurs with high tide; stream flooding much worse inland because of backwater effects.

***Dam and Levee Failure Floods**

- Dams and levees are engineered to withstand a flood with a computed risk of occurrence.
- If a larger flood occurs, the structure will be overtopped.
- If dam or levee fails or is washed out, water behind it becomes a flash flood which is catastrophic to life and property due to tremendous energy of released water.

Debris, Landslide, and Mudflow Floods

- Created by accumulation of debris, mud, rocks or logs, forming a temporary dam.
- Flooding occurs upstream; water is stored behind the dam and becomes a flash flood when the dam is breached and washes away.
- Landslides can create large waves on lakes and bays.
- Mudflow floods occur when volcanic activity melts snow and glaciers; the water, mud and debris move rapidly downslope.

The risk of flooding and flash floods is high in Oklahoma because of vast quantities of ground and surface water and flat land, and the occurrence of sporadic, severe storms. This report aims to increase awareness and

understanding of floods and provides basic information about the complex nature of floods with a portrait of flooding in Oklahoma, a description of flood-related submersion injuries that have occurred since 1988, and recommendations made by agencies involved in the study of all aspects of flooding that may reduce the number of lives lost and property damage.

Epidemiology of Flood-Related Submersion Injuries in Oklahoma

A total of 87 Oklahomans, 4% of all submersion injuries reported during 1988-2006, were hospitalized or died from an injury directly related to flood conditions; 75 persons (86%) died. The 25-34 year age group sustained nearly one-fourth of injuries; the 0-4 and 15-24 year age groups combined incurred a third of injuries. The male to female ratio was 2.5:1. The rate of injury was highest for whites (.21 per 100,000 population) followed by Native Americans (.13) and African Americans (.09). Alcohol was reported to be involved for 23% of persons aged 14 years and older. High winds were a contributory factor in 9% of cases. One injury was reported to be a homicide and one a suicide. The characteristics of flood-related injuries are shown in Table 1.

Forty percent of injuries occurred between 6:00 p.m. and 11:59 p.m. Sixty-seven persons (77%) were submerged over 15 minutes. The majority of submersion injuries occurred in creeks (52%), followed by rivers (19%) (Figure 1). Forty-five percent of injuries occurred among motor vehicle occupants; 15% of people were boating. Eight percent of injuries occurred among children playing or wading in swollen waters (Figure 2). Forty-four percent of injuries occurred on Thursday or Saturday. Forty-two percent of injuries occurred during the months of April to June. Although flood-related injuries occurred in thirty-three counties statewide, 61% occurred in eastern Oklahoma.

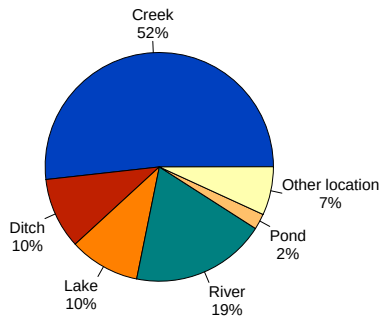
Electrical Hazards

High rushing flood waters can create an insidious hazard: exposure to electrical voltage that may injure or kill. Downed electrical lines and submerged equipment may not be seen or reported in time to interrupt power. Rivers, and especially creeks, may rise dramatically in 5 to 10 minutes. Lake levels rise with cumulative rain and stream collection and may rise enough to cover conduits that provide power to docks and

Table 1. Characteristics of Flood-Related Submersion Injuries in Oklahoma, 1988-2006 (N=87)

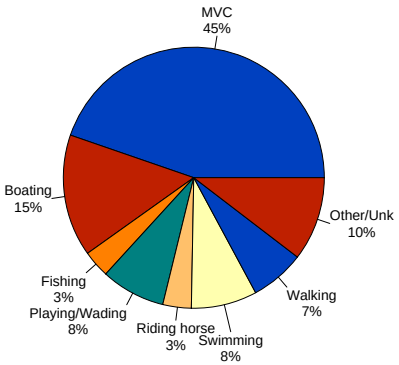
Characteristic	Number	Percent
Age: Range 0-93 years, Mean 30 years		
Age Group		
0-4	14	16%
5-14	9	10%
15-24	14	16%
25-34	19	22%
35-44	11	13%
45-54	7	8%
55-64	5	6%
65+	8	9%
Gender		
Male	62	71%
Female	25	29%
Substance Use (14 years and older)		
Alcohol	20	23%
Drugs	1	1%
Time of Injury		
12:00 a.m.-5:59 a.m.	12	16%
6:00 a.m.-11:59 p.m.	11	15%
12:00 p.m.- 5:59 p.m.	21	29%
6:00 p.m.-11:59 p.m.	29	40%
Survival factors		
Known to be swimmers	8	9%
Time submerged		
1-4 minutes	6	7%
5-9 minutes	3	3%
15-30 minutes	1	1%
30 minutes	66	76%
Unknown	11	13%
Resuscitation attempted	18	21%`
High winds a contributing factor	8	9%

Figure 1. Location of Flood-Related Submersion Injuries
Oklahoma, 1998-2006



Data Source: Surveillance System, Injury Prevention Service

Figure 2. Flood-Related Injuries by Type of Activity
Oklahoma, 1988-2006



Data Source: Surveillance System, Injury Prevention Service

other boating areas. In 2007, an Oklahoma man was stunned and temporarily paralyzed by an electric current when he jumped into a lake that was four feet above normal and covered the conduit that provided power to the dock. He survived because three people nearby came to his rescue. The following case reports demonstrate how quickly lives can be affected by flood waters.

Case Briefs

- A 2-year old wandered from home while playing, fell into a rain swollen ditch, and drowned.
- A teenager was driving a small car down a roadway during a spring downpour that had accumulated to 7 ½ inches. The car was swept away by flood waters and he did not survive.
- A 46-year old man was setting a fishing line and was swept away by the river's swift current from a recent heavy rainfall. He was trapped in logs and brush and did not survive.
- A canoeist was drinking beer and rafting while the river was in flood stage. He fell from the raft, was pushed up into the dam, and could not be saved.
- A 44-year old man was swept from a vehicle driven into a flooded intersection. He and his child drowned in the vehicle.
- A mother drowned when she jumped into a swollen river in an attempt to save her child from being carried downstream by the current. The child did not survive.

Discussion

A local, state/regional, and national approach is required to recognize why floods occur and to anticipate the measures needed to reduce occurrence and minimize flood effects and aftermath. On the national/international level, the focus of prevention is on disaster reduction through engineering, design and planning. Government and tribal agencies, nonprofit organizations, and the public work to ensure energy and water supplies, and educate/market warning systems and predictions. The network of agencies involved in flooding includes the USGS, National Oceanic and Atmospheric Administration (NOAA), National Flood Insurance Program (NFIP), U.S. Army Corps of Engineers (USACE), FEMA, and the Red Cross. Oklahoma agencies also directly engaged in floods and flood protection include Oklahoma Water Resources Board (OWRB), the Oklahoma Public Works Engineering Department, and the Lake Patrol. The Army Corps of Engineers, as mandated by Congress, has sole responsibility for the design and construction of the flood protection and levee system. In the U.S. and as delineated in the national response plan, "disaster response and planning is first and foremost a

local response. When local governments exhaust resources, they request additional resources from the state, and then on to federal government" as necessary.

Oklahoma Waters and Flood Risk

Groundwater. Oklahoma has 23 major groundwater basins. A groundwater basin is a distinct underground body of water overlain by contiguous land and having substantially the same geological and hydrological characteristics and yield capabilities. Ogallala Aquifer contains 86.6 million acre-feet of water – enough to cover the state with water two feet deep. An aquifer is a formation that contains sufficient saturated, permeable material to yield significant quantities of water to rivers and springs.[5]

Surface water. Oklahoma has 11,611 miles of shoreline which is slightly less than the estimated combined general coastline of the Atlantic, Pacific and Arctic Coasts (12,383 miles) that includes:

- 78,578 miles of rivers and streams
  - 1,120 square miles of water in Oklahoma's 909 lakes and approximately 250,000 ponds
  - An estimated 34 million acre-feet of water that flows out of the state
  - Oklahoma's two major river basins are the Red and Arkansas rivers.

Approximately 40,000 streams in the state are in the boundaries of the regulatory floodplains but less than 10,000 are covered by flood insurance. One inch of rain falling on a 160-acre field delivers 4,344,680 gallons of water or 13.3 acre flood.[6]

Human factors leading to compromise with floods and submersion injury include: 1) insufficient knowledge of floods and the hazards of the rapid accumulation and passage of waters; 2) not knowing what actions to take in a flash flood situation; and 3) having limited opportunities to get out of the situation safely and in time. Also, assessing the need for and purchasing flood insurance is essential to recovering from the ravages of flooding. Since 1978, when the Flood Insurance Program was fully established, there have been 18,906 flood insurance claims with $243 million paid in Oklahoma.

Recommended Prevention/Control Measures

FEMA and the OWRB suggest citizens know flood terms and what to do before, during, and after a flood. If you live on a designated floodplain – and each state has flood plains – chances are one in two that you will experience a flood in your lifetime.

Long-term Preparedness

- Determine whether you live in a potential flood zone; learn your vulnerability to flooding by assessing flood risk and elevation above flood stage in your area to allow for planning evacuation routes.
- Have flood insurance; floods are not usually covered by regular homeowners insurance.
- Check with National Flood Insurance Program (1-888/call-flood, ext. 445)
- Be aware of local streams, drainage channels, rivers, and areas known to flood easily during heavy rains so evacuation routes are not cut off.
- Know your community's existing flood warning system and evacuation plans.
- Develop a flood emergency action plan; families should plan ahead where to meet and how to contact emergency medical services/911, and know how to turn off water, gas, and electricity.
- Keep a disaster supplies kit on hand including first aid materials, a radio, emergency cooking equipment, and flashlights.
- Prepare a stock of food and have drinking water stored in containers.
- In highly flood-prone areas, keep on hand sandbags, plywood, plastic sheeting, plastic rubbish bags, lumber, shovel, work boots and gloves.

Before a Flood

- Monitor NOAA's weather radio and local radio/news media for latest statements, warnings, and road conditions about floods.

- If advised to evacuate and move to a safe area, do so before access is cut off by flood waters.
- Listen for flash flood or flood water watch/warning, the urban and small stream advisory, and flood follow-up information.
- With a flood warning, remember that you may have only seconds to save yourself and others.
- Look for signs of flash flooding (sudden rise in water level, noise of water), and be ready to evacuate immediately.

During a Flood

- Keep out of areas subject to flooding such as dips, low spots, canyons, creeks, and ditches.
- Restrict children from playing in flooded areas.
- Avoid already flooded areas. If you come to a flowing stream with water above your ankles, stop, turn around, and go another way.
- Do not attempt to swim, fish, or boat on creeks, rivers, or lakes that are flooded.

Recommendations Specific to Motor Vehicles

- Nearly half of all flash flood submersions are motor vehicle-related. Occupants should look out for flooding at highway dips, bridges, low areas, and creeks and streams that proximate roads.
- Don't camp or park your vehicle along streams and washes, especially during threatening weather conditions.
- Don't attempt to drive over a flooded road. The roadway may have collapsed due to erosion, or you may drive into a washout. Even six inches of water may cause you to lose control of your vehicle. Two feet will sweep most cars off the road.
- Be especially cautious at night when it is harder to recognize flood dangers.
- TURN AROUND, DON'T DROWN (TADD)
- If vehicle stalls due to water, abandon it and seek higher ground.
- Relate what you know about flooding as you drive through other states/regions.

After a Flood

- Avoid disaster areas so that you do not hamper rescue and emergency operations.
- Have your electrical equipment checked before returning to service.
- Use flashlights instead of lanterns or candles to examine buildings since flammables may be present.

Recommendations Specific to Public Health Issues and Disasters

- Assess needs of population, match resources to needs, prevent further adverse effects, evaluate program effectiveness, and plan for future disasters.
- Discourage citizens from moving into flood damaged homes and businesses because the structures may have become contaminated by the floodwaters and be a health risk.
- Test drinking water for potability; water should be pumped out and the water tested before drinking.
- Throw out any food that came in contact with flood water and boil drinking water.
- Wash covered goods that came in contact with floodwater with hot water.
- Be aware that residential waters may hold raw sewage, bacteria, heavy metals, pesticides, toxic chemicals, or oil.
- Improve the post disaster environment so as to provide:
  - Access to adequate sources of potable water, and disposal and treatment of excreta, and other liquid and solid wastes;
  - Install appropriate number of disposal facilities (latrines, field, solid waste), pickup points, water distribution points, availability of bathing and washing facilities, and soap;
  - Control disease vectors (mosquitoes, flies, rats and fleas) to further protect community from disease.

The risk of epidemic outbreaks of communicable diseases is proportional to population density and displacement. There exists increased pressure on water and food supplies and risk of contamination, and the disruption of preexisting

sanitation services such as piped water and sewage. Nutrition is affected when flooding damages household food stocks and crops, disrupts distribution and causes local food shortages.[7] The physical status of the population may also be undermined due to interruption and non-availability of daily medications.

Future Flood Prevention

To make citizens aware of flooding problems and solutions, Governor Henry designated May as Flood Awareness Month in Oklahoma in 2007. He encouraged the OWRB and other agencies to expand knowledge to the public on floodplain management techniques and flood safety procedures, and to spread the word about the availability of affordable flood insurance through the FEMA National Flood Insurance Program. Currently, 88% of homes and businesses in the state do not have flood insurance, which must be purchased separately from homeowner's insurance. The OWRB, State Floodplain Management, and Oklahoma Floodplain Association suggest that ways to prevent future flood problems in communities are to elevate, relocate or demolish repeatedly-damaged structures, and not to build in flood-prone areas.

Through the Public Assistance Program, FEMA reimburses state and local governments and some nonprofit organizations for costs associated with repairing or demolishing disaster-damaged infrastructure such as roads and bridges, public buildings, utilities, parks, and recreation areas. Following a flood disaster, accurate information must be obtained and, through a joint decision-making process, the needs of the disaster-affected populations must be assessed, available resources matched to needs to prevent further adverse health effects, disease control strategies implemented, and contingency plans developed.

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