# SECTION 2: HUMAN IMPACTS ON FLOODING

## Contents

## 2.1. WATERSHED AND FLOODPLAIN DEVELOPMENT

Floodplains account for only seven percent of the nation's total land area. However, they contain a tremendous amount of property value. It is estimated that there are 8 – 12 million homes in the nation's floodplains.

Several problems result from floodplain development:

- Development alters the floodplain and the dynamics of flooding.
- Buildings and infrastructure are damaged by periodic flooding.
- Water-dependent habitat is destroyed.

Human development can have an adverse impact on flooding. Problems arise in two areas: the watershed (where the water comes from) and the floodplain (where it goes).

### 2.1.1. Watersheds

Development in riverine watersheds affects the runoff of stormwater and snowmelt. Buildings and parking lots replace the natural vegetation which used to absorb water. When rain falls in a natural setting, as much as 85% of it will infiltrate the ground, evaporate, or be absorbed by plants; in an urbanized area, as much as 60% of it will run off (Figure 2-1).

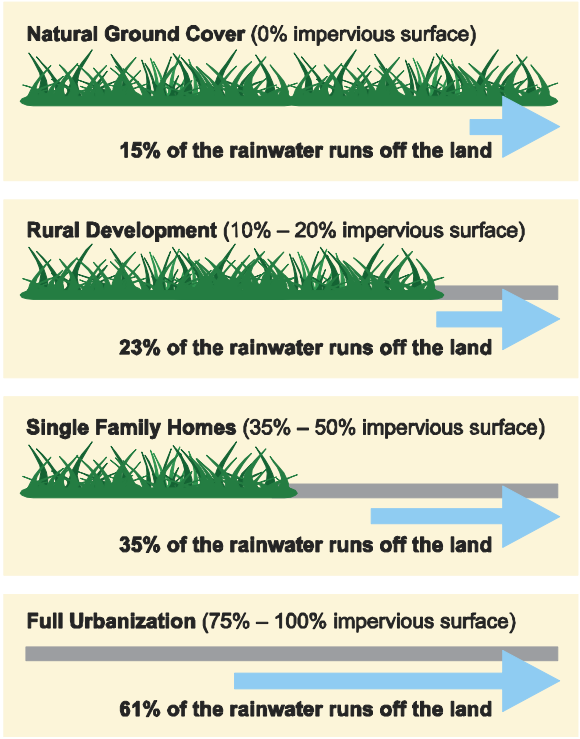



**Figure 2-1: Effects of development on stormwater runoff.**
Note: These are typical conditions. Actual runoff varies with the length of the storm, soil type, and degree of ground saturation before the storm.

Urban features, such as buildings, pavement, storm sewers, mowed lawns, etc., alter flood dynamics as well. Storm sewers and more efficient ditches that come with urban drainage systems speed flood flows. The result of urbanization is that there is more runoff in the watershed and it moves faster, increasing flooding downstream. Thus, a 10-year storm may produce the runoff equivalent of a 25-year storm, overloading the man-made drainage system.

Urbanization also changes the timing of flows along the tributaries. If one subwatershed develops faster than another, the peak flows will leave the developed watershed faster than it used to, possibly arriving at the main channel at the same time as the peak flows from another tributary, causing increased flooding downstream.

### 2.1.2. Floodplains

The most obvious impact of development on riverine flooding comes with moving or altering channels or constructing bridges and culverts with small openings. Construction and filling in of the floodplain can obstruct flood conveyance, reduce available floodplain storage, and potentially increase flood heights. Levees and dikes are the best known examples of this, but even small construction projects have an impact.

Filling obstructs flood flows, backing up floodwaters onto upstream and adjacent properties (Figure 2-2). It also reduces the floodplain's ability to store excess water, sending more water downstream and causing floods to rise to higher levels. This increases floodwater velocity. Filling reduces the area available for infiltration and recharging of ground water levels.

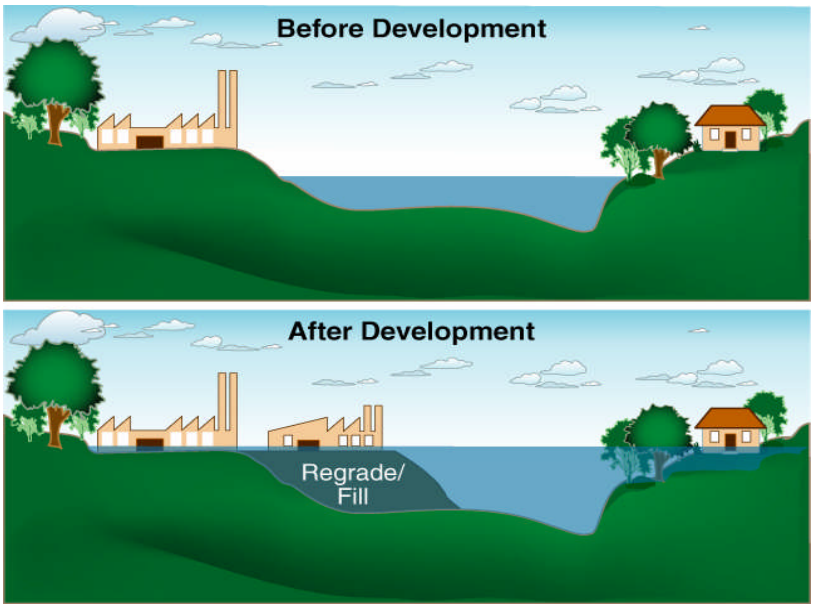



**Figure 2-2: Effects of development on a riverine floodplain**

## 2.2. SAFETY AND HEALTH HAZARDS

Over 8 million families in the United States live in the floodplain. Millions more work in floodplains or drive through them everyday. In an average year, floods kill 150 people and cause over $3 billion in property damage. Nationally, average annual flood losses continue to increase.

Floods can hurt or kill people and damage property, in several ways. Knowing the impact of a potential hazard — and guarding against it — is integral to administering a floodplain management program.

Floods pose a variety of hazards as they build, crest, and subside. At different points in the life of a flood, people are displaced, damage occurs, and finally a cleanup can begin. In addition to the threat of drowning, disruption of normal public utilities and the presence of flood debris and damage can produce safety and health hazards to residents and emergency response personnel.

### 2.2.1. Safety hazards

Studies have shown that it doesn't take much depth or velocity to knock a person over (Figure 2-4). No areas with moving floodwater can be considered safe for walking (Figure 2-3 and Figure 2-4). Drowning in vehicles is the number one cause of flood deaths. The hazards of driving in flooded waters are explained in Figure 2-5.

A car will float in only two feet of moving water, which is one reason floods kill more people trapped in vehicles than anywhere else. Often victims put themselves in perilous situations by ignoring warnings about travel or mistakenly thinking that a washed-out bridge is still open.

**Figure 2-3: Even shallow floodwaters can stop cars and wash people off their feet**
Source: Roanoke Times and World News

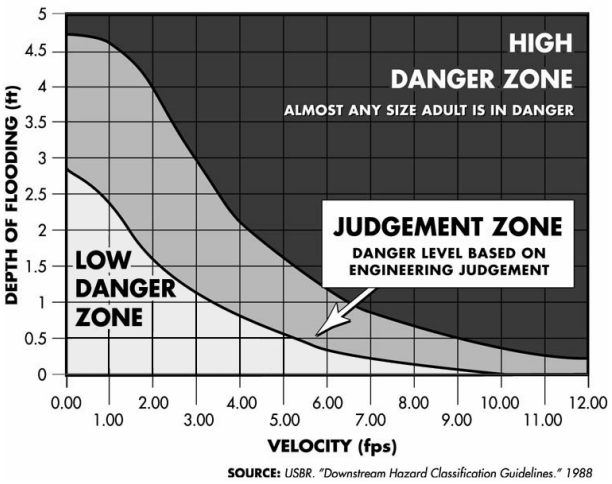
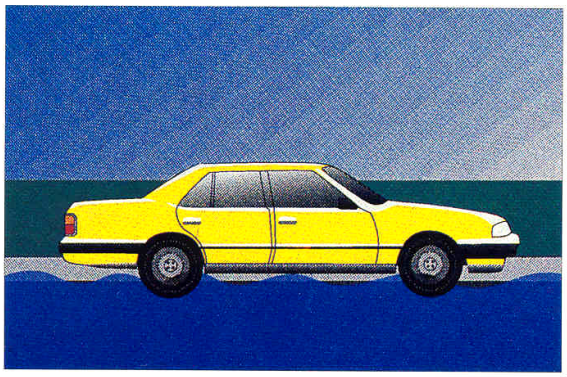



**Figure 2-4: Depth and velocity hazard chart**

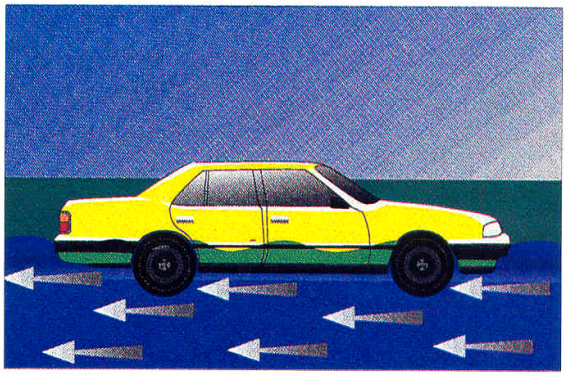
Electrocution is the second most frequent cause of flood deaths, claiming lives in a flooded area that is carrying a live current created when electrical components short. People die of heart attacks, especially from exertion during a flood fight. Floods also can damage gas lines, floors, and stairs, creating secondary hazards such gas leaks and unsafe structures. Propane tanks can float, causing gas leaks and sending explosive 'torpedoes' downstream.

Fire can be a result of too much water: floods can break gas lines, extinguish pilot lights, and short circuit electrical wiring – causing conditions ripe for a fire. Fire equipment may not be able reach a burning building during high water.

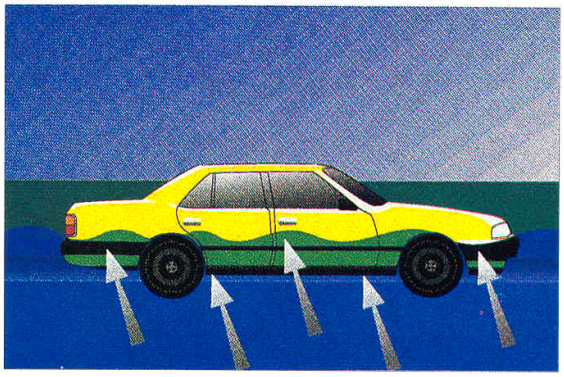
Safety precautions are listed in the instructions on page 2-6. These are taken from IAFSM's booklet, *Guide to Flood Protection in Northeastern Illinois*. Copies of the booklet are available free from IAFSM (www.illinoisfloods.org) and can be copied by communities for their residents.



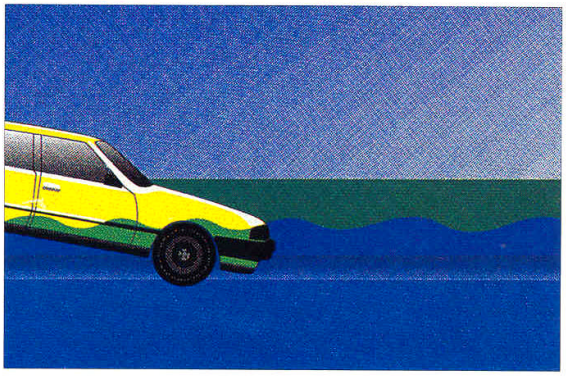
Water weighs 62.4 lbs. per cubic foot and typically flows downstream at 6 to 12 miles an hour.



When a vehicle stalls in the water, the water's momentum is transferred to the car. For each foot the water rises, 500 lbs. of lateral force are applied to the car.



But the biggest factor is buoyancy. For each foot the water rises up the side of the car, the car displaces 1,500 lbs. of water. In effect, the car weighs 1,500 lbs. less for each foot the water rises.



***Two feet of water will carry away most automobiles.***

**Figure 2-5: Effects of shallow water on cars**
Source: *Flash Floods and Floods … The Awesome Power*, National Weather Service, 1992.

## Flood Safety Outdoors

Do not walk through flowing water. Drowning is the number-one cause of flood deaths. Currents can be deceptive; six inches of moving water can knock you off your feet. Use a pole or stick to ensure that the ground is still there before you go through an area where the water is not flowing.

Do not drive through a flooded area. More people drown in their cars than anywhere else. Don't drive around road barriers; the road or bridge may be washed out. A car can float in as little as two feet of water.

Stay away from power lines and electrical wires. The number two flood killer after drowning is electrocution. Electrical current can travel through water. Report downed power lines to the power company.

## Flood Safety Indoors

Turn off your electricity if your building is flooded. If you don't know how, call an electrician. Some appliances, such as television sets, can shock you even after they have been unplugged. Don't use appliances or motors that have gotten wet unless they have been taken apart, cleaned, dried and inspected by a professional.

Watch for animals. Small animals like rats and snakes that have been flooded out of their homes may seek shelter in yours. Use a pole or stick to poke and turn items over and scare away small animals.

Look before you step. After a flood, the ground and floors are covered with debris including broken bottles and nails. Floors and stairs that have been covered with mud can be very slippery.

Be alert for gas leaks. Use a flashlight to inspect for damage. Don't smoke or use candles, lanterns, or open flames unless you know the gas has been turned off and the area has been thoroughly aired out. If you have questions on gas, call the gas company.

Carbon monoxide exhaust kills. Use a generator or other gasoline-powered machine outdoors. The same goes for camping stoves. Fumes from charcoal are especially deadly — cook with charcoal outdoors.

Clean everything that got wet. Flood waters have picked up sewage and chemicals from roads, farms, factories, and storage buildings. Spoiled food and flooded cosmetics and medicines are health hazards. When in doubt, throw them out.

Take good care of yourself. Wear gloves and boots. Wash your hands frequently during clean up. Recovering from a flood is a big job. It is tough on both the body and spirit and the effects a disaster has on you and your family may last a long time. Keep your eyes open for signs of anxiety, stress, and fatigue in you and your family.

### 2.2.2. Health hazards

Floods bring and leave health hazards in the form of animal carcasses, garbage, and ponds that can become breeding grounds for germs and mosquitoes. Any flooded items that come in close contact with people must be thrown out, including such things as food, cosmetics, medicines, stuffed animals, and baby toys. Clothes and dishes need to be washed thoroughly.

Rain and floodwaters infiltrate into sanitary sewer lines. There is nowhere for the sewage to flow when wastewater treatment plants are flooded. Infiltration and lack of treatment lead to overloaded sewer lines that back up into low-lying areas and some houses. Even though it is diluted by floodwaters, raw sewage can be a breeding ground for bacteria, such as E. coli and other disease-causing agents.

If the water system loses pressure, a boil order may be issued to protect people and animals from contaminated water. Private wells need to be tested by the local health department before the water is deemed safe to drink. Septic systems are put out of operation when under water, adding to the health hazard of a flood.

Another type of health hazard comes about after the water is gone. Stagnant pools become breeding grounds for mosquitoes and wet areas of a building that have not been cleaned breed mold and mildew (Figure 2-6). A building that is not thoroughly and properly cleaned becomes a health hazard, especially for small children and the elderly.

**Figure 2-6: Post-flood silt, mold, and mildew**

An additional health hazard occurs when heating ducts in a forced-air system are not properly cleaned after inundation. When the air conditioner is turned on, the sediments left in the ducts are circulated throughout the building and breathed in by the occupants.

For additional information and guidance on protecting against the health hazards of flooding, see pages 2-3 in the FEMA/Red Cross book Repairing Your Flooded Home which can be found at:

www.redcross.org/services/disaster/0,1082,0_570_,00.html.

### 2.2.3. Mental health

Flooding, especially repetitive flooding, takes a toll on people's mental health. Stress comes from facing the loss of time, money, property, and personal possessions such as heirlooms. This is aggravated by fatigue during cleanup and anxiety over lost income, health risks, and damage to irreplaceable items. Children and the elderly are especially susceptible to stress from the disruption of their daily routines.

## 2.3. FLOOD DAMAGE

A floodplain management administrator needs to be knowledgeable about the six main causes of flood damage:

1. Hydrodynamic forces
2. Debris impact
3. Scour
4. Hydrostatic forces
5. Soaking
6. Sediment and contaminants

### 2.3.1. Hydrodynamic forces

Moving water creates a hydrodynamic force which can damage a building's walls in three ways (see Figure 2-7):

1. Frontal impact, as water strikes the structure.
2. Drag effect, as water runs along the sides of a structure.
3. Eddies or negative pressures, created as water passes the downstream side.

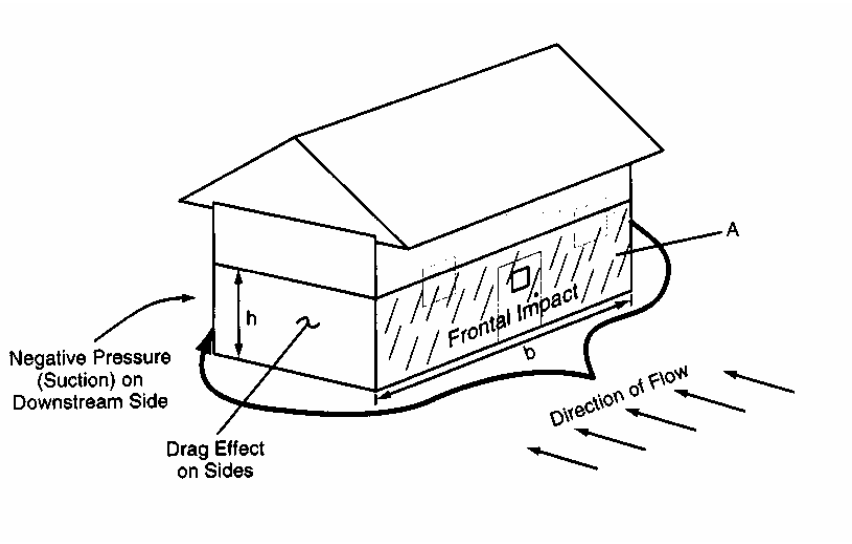



**Figure 2-7: Hydrodynamic forces on a building.**

The speed of moving water is called velocity, a movement that is measured in feet per second. The faster water moves, the more pressure it puts on a structure and the more it will erode stream banks and scour the earth around a building's foundation.

Floodwaters moving faster than 5 feet per second comprise a high-velocity flood, requiring special design considerations for buildings, roads, bridges, and other manmade structures in its path. Velocity is one factor in determining the potential harm of a flood. The total impact of

moving water is related to the depth of the flooding. Studies have shown that deep water and low velocities can cause as much damage as shallow water and high velocities.

### 2.3.2. Debris impact

Debris also increases the hazard posed by moving water. Floodwaters can and will pick up anything that will float — logs, lumber, ice, even propane tanks and vehicles. Moving water will also drag or roll objects that do not float. All of this debris acts as battering rams that can knock holes in walls (Figure 2-8).

**Figure 2-8: Ice floes and other large items of debris can crush a house (Kankakee River, 1985)**

### 2.3.3. Scour

Scour occurs when water flows at high velocities past an object embedded in or resting on erodible soil. Flow moving past a fixed object must accelerate, often forming eddies and scouring loose sediment from the immediate vicinity of the object. Localized scour around piles and similar objects is generally limited to small, cone-shaped depressions (less than 2 feet deep and several feet in diameter). Localized scour is capable of undermining slabs and grade-supported structures.

### 2.3.4. Hydrostatic forces

The weight of standing water puts hydrostatic pressure on a structure. The deeper the water, the more it weighs and the greater the hydrostatic pressure. Because water is fluid, it exerts the same amount of pressure sideways (lateral pressure) as it does downward. As water gets deeper, it exerts more lateral pressure than shallow water (Figure 2-9).

Most walls are not built to withstand lateral pressure. Studies and tests have shown that the lateral force presented by three feet of standing water can be enough to collapse the walls of a typical frame house.

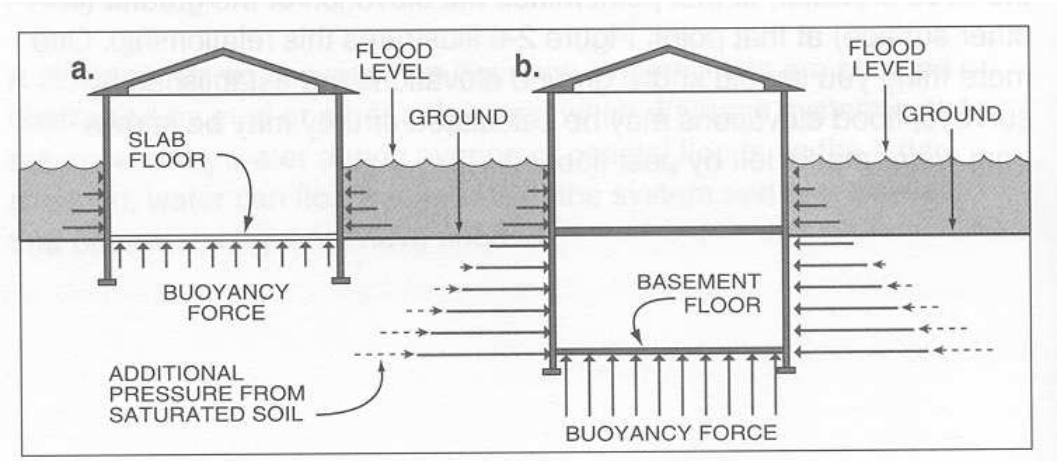



**Figure 2-9: Hydrostatic pressure increases with deeper water**

Basement walls and floors are particularly susceptible to damage by hydrostatic pressure. Not only is the water deeper but a basement is also subjected to the combined weight of water and saturated earth. Water in the ground underneath a flooded building will seek its own level – resulting in uplift forces that can break a concrete basement floor (Figure 2-10).

One proven approach to counter uplift is to fill a basement with clean water before a flood. The weight of the water in the basement acts as a counter force to the hydrostatic pressure, protecting the walls and floor.

**Figure 2-10: This basement floor broke from hydrostatic pressure**

### 2.3.5. Soaking

When soaked, many materials change their composition or shape. Wet wood will swell, and if it is dried too fast, it will crack, split, or warp. Plywood can come apart. Gypsum wallboard will fall apart if it is bumped before it dries out. The longer these materials are wet, the more moisture they will absorb. Walls present a special problem: a "wicking" effect pulls water up through wood and wallboard, soaking materials as much as several feet above the actual high water line (see Figure 2-11).

**Figure 2-11: Prolonged exposure to water and "wicking" can destroy wood and gypsum walls.**

Soaking can cause extensive damage to household goods. Wooden furniture may get so badly warped that it can't be used. Other furnishings, such as upholstery, carpeting, mattresses, and books, usually are not worth drying out and restoring. Electrical appliances and gasoline engines won't work safely until they are professionally dried and cleaned.

### 2.3.6. Sediment and contaminants

Few floods have clear floodwater and, as such, they leave a mess made of natural and man-made debris. Stormwater, snowmelt, and river water pick up whatever was on the ground, such as soil, road oil, and farm and lawn chemicals. If a wastewater treatment plant upstream was inundated, the floodwaters will likely include untreated sewage.

Many materials, including wood and fiberglass or cellulose insulation, absorb floodwater and its sediment. Even if allowed to dry out, the materials will still hold the sediment and contaminants brought by the flood. Simply letting a flooded house dry out will not render it clean — and it certainly will not be as healthy a place as it was before the flood.