PART 1:

FLOODING AND FLOODPLAIN MANAGEMENT

Part 1 lays the groundwork for this desk reference by explaining:

- The more common types of floods and floodplains.
- How floods affect floodplain development.
- The strategies and tools for floodplain management.
- Federal and State floodplain management agencies and programs.
- Basic terms used throughout the desk reference.

SECTION 1: NATURAL ASPECTS OF FLOODING

Contents

1.1. RIVERINE FLOODING PROCESS

1.1.1. Introduction

Throughout time, floods have altered the floodplain landscape. These areas are continuously shaped by the forces of water — either eroded or built up through deposit of sediment. More recently, the landscape has been altered by human development, affecting both the immediate floodplain and events downstream.

Historically, people have been attracted to bodies of water as places for living, industry, commerce, and recreation. During the early settlement of Illinois, locations near water provided necessary access to transportation, a water supply, and water power. The bluff areas along rivers provided better drainage and drier ground than the upland prairies.

This pattern of development continued as communities grew. In recent decades, development along waterways and shorelines has been spurred by the aesthetic and recreational value of these sites. As development pressures have increased in the metropolitan areas, floodprone areas that had been avoided are now being built on. The result has been an increasing level of damage and destruction created by the natural forces of flooding on human development.

The purpose of this desk reference is to familiarize floodplain administrators with how this problem can be curbed through proper management of how the floodplains are developed. Communities that guide development following the State and national standards have seen the results – their new buildings and neighborhoods have had less damage and suffering from flooding.

1.1.2. The hydrologic cycle

Floods are part of the Earth's natural hydrologic cycle. The cycle circulates water throughout the environment (Figure 1-1). This process maintains an overall balance between water in the air, on the surface, and in the ground.

Sometimes the hydrologic cycle gets outs of balance, sending more water to an area than it can normally handle. The result is a flood.

A flood inundates a floodplain. There are different types of floodplains and they are based on the type of flooding that forms them.

Most floods in Illinois fall into one of two major categories:

1. Riverine flooding (Section 1.2)

2. Shallow flooding (Section 1.3)

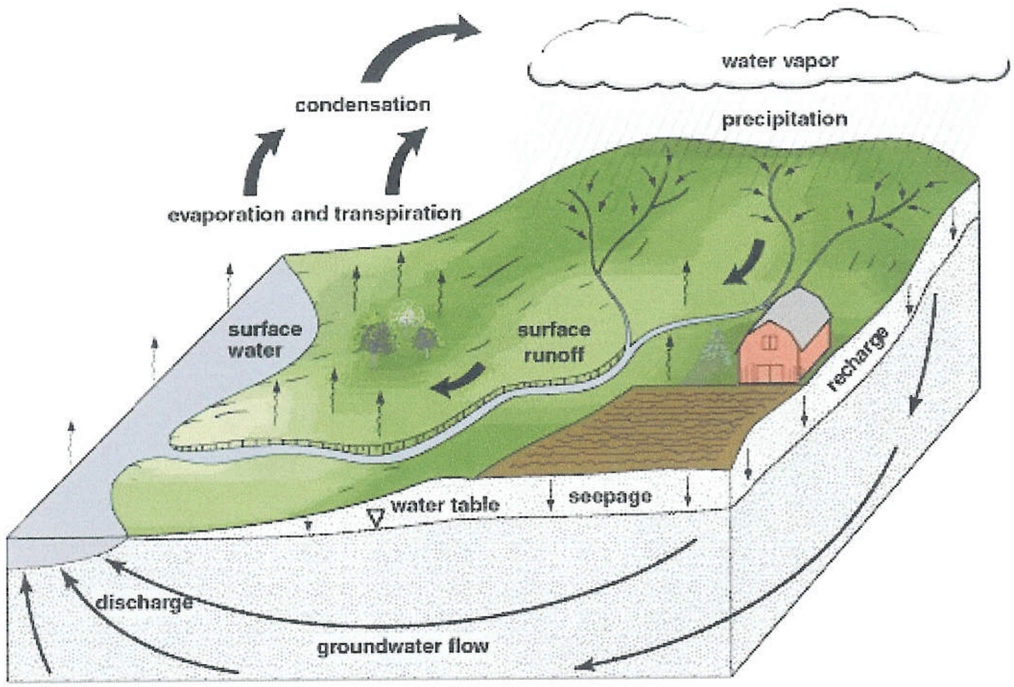

Figure 1-1: The Hydrologic cycle
Source: Illinois State Geological Survey

1.1.3. Watershed

A watershed is an area that drains into a lake, stream, or other body of water. Other names for it are basin or catchment area. Watersheds vary in size, and larger ones can be divided into sub-watersheds.

Figure 1-2 shows a watershed and some of the key terms. The boundary of a watershed is a ridge or a divide. Water from rain and snowmelt are collected by the smaller channels (tributaries), which send the water to larger ones and eventually to the lowest body of water in the watershed (main channel).

Channels are defined features on the ground that carry water through and out of a watershed. They may be called rivers, creeks, streams, or ditches. The major watercourses can flow all year due to the abundance of precipitation. However, the smaller, upland channels may have intermittent flow.

1.2. RIVERINE FLOODING

When a channel receives too much water, the excess water flows over its banks and into the adjacent area. Flooding that occurs along a channel is called riverine flooding.

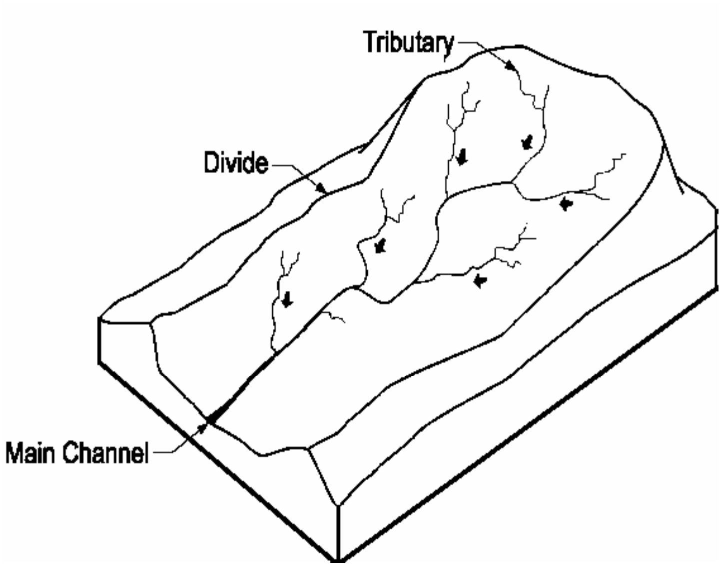

Figure 1-2: Riverine Watershed and Floodplain

What happens in a watershed will affect events and conditions downstream. Terrain helps determine the dynamics of riverine flooding. In relatively flat areas, shallow, slow-moving floodwater may cover large areas of land for days or even weeks. In hilly areas and along bluffs, a flood may come and go in minutes after a heavy rain.

1.2.1. Overbank flooding

The most common type of flooding in Illinois is overbank flooding (Figure 1-3). Overbank flooding occurs when a downstream channel receives more rain or snowmelt from its watershed than it can handle, or a channel is blocked by an ice jam or debris. For either reason, excess water overloads the channel and flows over the channel's bank and out onto the floodplain.

Overbank flooding varies with the watershed's size and terrain. One measure of a flood is the speed of its moving water, which is called velocity. Velocity is measured in feet per second. Hilly areas tend to have narrow floodplains with faster moving water, so velocity can pose a serious hazard. In flat areas, the floodplain can be very wide and floodwaters may move slowly, making its velocity less of a hazard.

Terrain may affect how much warning people have that a flood is building. A river that drains a large watershed may have hours or even days of advance notice. On the other hand, smaller streams in hilly areas may give no warning that a flood is about to strike.

Flood depths vary, as do flood durations. Generally, the larger the river, the deeper the flood and the longer it will last. However, in hilly or mountainous areas with narrow valleys, flooding can be very deep in small watersheds. Depending on the size of the river and terrain of its floodplain, flooding can last for days and cover wide areas.

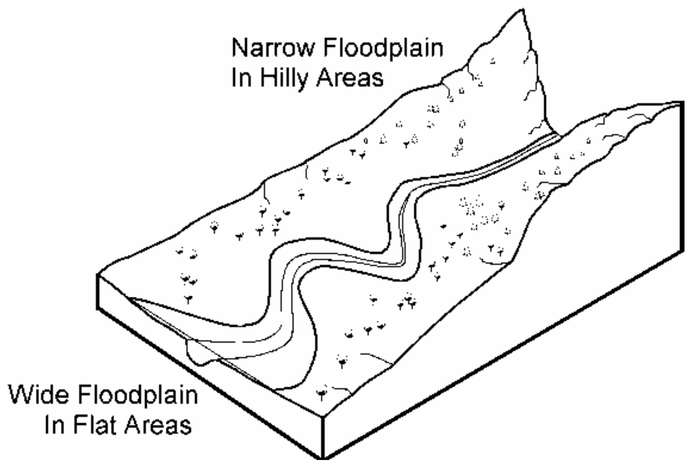

Figure 1-3: Riverine floodplain

1.2.2. Flash flooding

A severe storm that drops much rainfall in a short time can generate a flash flood. All flash floods strike quickly and end swiftly. Areas with steep slopes and narrow stream valleys are particularly vulnerable to flash flooding, as are the banks of small tributary streams. In hilly areas, the high-velocity flows and short warning time make flash floods hazardous and very destructive.

In urban areas, flash flooding can occur where impervious surfaces, gutters, and storm sewers speed runoff. Flash floods also can be caused by dam failure, the release of ice-jam flooding, collapse of debris dams, or failure of a levee.

Flash floods rank first as the cause of flood-related deaths in the United States. In the 1970s, four flash floods in a five-year period killed 570 people.

- In 1972, 118 people died along Buffalo Creek in West Virginia when an embankment made of coal refuse washed out, destroying 546 houses and damaging as many more.
- Weeks later, 236 people died when heavy rain and a dam failure inundated the area near Rapid City, South Dakota. Property damage exceeded $100 million.
- In 1976, heavy rains spawned floods in Colorado's Big Thompson Canyon, killing 139 people.
- The next year, 77 people died in Johnstown, Pennsylvania, when heavy rain overwhelmed a dam, causing $200 million in damage.

These figures have not been seen in Illinois because most of the state is flat and not conducive to deep flash flooding. For example, the death toll from the record 1993 Mississippi River flood was low because it rose over several weeks, giving people time to evacuate.

1.2.3. Riverine erosion

River channels change as water moves downstream, acting on the channel banks and on the channel bottom (the thalweg). This force becomes more potent during a flood, when the river's velocity increases.

Several features along a river are affected by this flow of water in different ways. A meander is a curve in a channel. On the outside of a meander, the banks are subject to erosion as the water scours against them (Figure 1-4). On the other hand, areas on the inside of meanders receive deposits of sand and sediment transferred from the eroded sites.

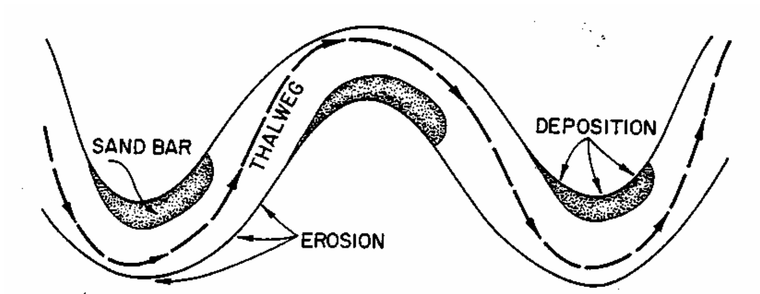

Figure 1- 4: Erosion changes the shape of channels

Figure 1-5: Riverine erosion can undercut structures

Properties on the outside of curves face a double threat of inundation and undercutting from riverine erosion during floods (Figure 1- 5).

In addition, meanders do not stay in the same place — they migrate slowly downstream and across the floodplain, reworking the shape of the channel within the floodplain.

1.3. SHALLOW FLOODING

Shallow flooding occurs in flat areas where a lack of channels means water cannot drain away easily. Shallow flood problems fall into three categories: sheet flow, ponding, and urban drainage.

1.3.1. Sheet flow

In areas where there are inadequate or no defined channels, floodwater spreads out over a large area at a somewhat uniform depth in what is called sheet flow. Sheet flows occur after an intense or prolonged rainfall during which the rain cannot soak into the ground. During sheet flow, the floodwaters move downhill and cover a wide area.

1.3.2. Ponding

In some flat areas, runoff collects in depressions and cannot drain out, creating a ponding effect. Ponding floodwaters do not move or flow away. Floodwaters will remain in the temporary ponds and depressional storage areas until they infiltrate into the soil, evaporate, or are pumped out.

Ponding is especially a problem in the glaciated areas of northern Illinois, where glaciers carved out depressions. It is also common in areas where man-made features, such as roads and railroad embankments, have blocked outlets. An example of the latter is in the areas protected by levees along the large rivers. Being in floodplains, these areas are flat and don't drain naturally, especially when a levee blocks the flow to the river.

To drain these areas, channels have been built and pumps installed to mechanically move the water. Often, these man-made systems do not have the capacity to handle heavy rains or intense storms.

1.3.3. Urban drainage

An urban drainage system is comprised of the natural channels and man-made ditches, storm sewers, retention ponds, and other facilities constructed to store runoff or carry it to a receiving stream or lake. Other features in such a system include yards and swales that collect runoff and direct it to the streams, sewers, and ditches.

When most of the man-made systems were built, they were typically designed to handle the amount of water expected during a 10-year or smaller storm. Larger storms overload them and the resulting backed-up sewers and overloaded ditches produce shallow flooding.

1.4. OTHER FLOOD HAZARDS

The flooding types described so far are the more common types found in Illinois. There are many special local situations in which flooding or flood-related problems do not fit the norm.

1.4.1. Lake flooding

The Great Lakes are so large; they sometimes act as small oceans. Severe storms can produce waves and cause shoreline erosion. The Department of Homeland Security's Federal Emergency Management Agency (FEMA) is starting to map Great Lakes flooding with the same techniques it uses for ocean coastal flooding.

Persistent high wind and changes in air pressure push the Lake Michigan's water toward the shore, causing a seiche which can raise the level of the lake by 2-3 feet. Waves can be highly destructive as they move inland, battering structures in their path.

Flooding on Lake Michigan is not a great problem in Illinois because over 60% of the lakefront is publicly owned open space. Most of the rest is along high bluffs, above flood levels, but where erosion is the greater hazard. Therefore, this desk reference does not cover the type of flooding found along Lake Michigan's shoreline.

On other lakes, runoff and high flows from flooding rivers cause the lake level to rise. On the larger lakes, the wide open area or fetch, allows wind to kick up waves that cause more damage than the high water. This phenomenon also occurs on wide rivers, such as "Lake Peoria" on the Illinois River.

1.4.2. Levee and dam failures

Levees and dams are designed to hold back large amounts of water. If they fail or are over-topped, they can produce a dangerous flood situation because of the high velocities and large volumes of water released. Levee flooding is caused by overtopping, failure, or seepage through or under the structure. It occurs during a flood on the river so people are usually alerted to a potential problem.

A break in a dam, on the other hand, can occur with little or no warning on clear days when people are not expecting rain, much less a flood. Breaching often occurs within hours after the first visible signs of dam failure, leaving little or no time for evacuation. (As noted in the earlier section on flash flooding, three of the four top killer floods in the 1970s were related to the failure of a dam or dam-like structure.)

Dam breaks occur for one of three reasons:

1. The foundation fails due to seepage, settling or earthquake,
2. The design, construction, materials or operation were deficient, or
3. Flooding exceeds the capacity of the dam's spillway.

Proper design can prevent dam breaks. While IDNR's Dam Safety Program helps ensure that new dams are properly designed, there are still many private or locally built dams that were poorly designed and maintained.

1.4.3. Ice jams

Ice jam flooding generally occurs when warm weather and rain break up frozen rivers or any time there is a rapid cycle of freezing and thawing. It can be almost an annual occurrence in late winter along northern Illinois streams, like the Kankakee and the Fox.

The broken ice floats downriver until it is blocked by an obstruction such as a bridge or shallow area (Figure 1-6). An ice dam forms, blocking the channel and causing flooding upstream.

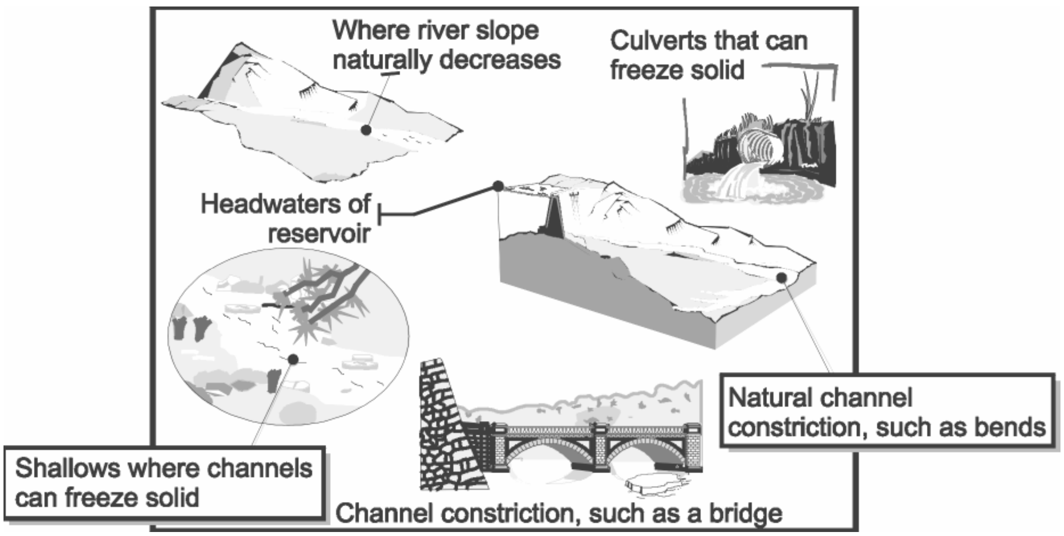

Figure 1-6: Likely Ice Jam Areas

Ice jams present three hazards:

1. Sudden flooding of areas upstream from the jam, often on clear days with little or no warning.
2. Movement of ice chunks (floes) that can push over trees and crush buildings (see Figure 2-8).
3. Sudden flooding of areas downstream when an ice jam breaks. The impact is similar to a dam break, damaging or destroying buildings and structures.

1.5. NATURAL AND BENEFICIAL FLOODPLAIN FUNCTIONS

Floodplain lands and adjacent waters combine to form a complex, dynamic physical and biological system found nowhere else. When portions of floodplains are preserved in (or restored to) their natural state, they provide many benefits to both human and natural systems.

These benefits range from providing aesthetic pleasure to reducing the number and severity of floods, helping handle stormwater runoff, and minimizing nonpoint water pollution (see Figure 1-7). For example, by allowing floodwater to slow down, sediments settle out, thus maintaining water quality. The natural vegetation filters out impurities and uses excess nutrients. Such natural processes cost far less money than it would take to build facilities to correct flood, stormwater, water quality, and other community problems.

Figure 1-7: Wetlands store and filter floodwaters and help recharge aquifers
Source: Lake County Stormwater Management Commission

Natural resources of floodplains fall into three categories: water resources, living resources, and societal resources. The following sections describe each category's natural and beneficial functions. For more information on natural and beneficial floodplain functions, see *Protecting Floodplain Resources – A guidebook for Communities.*

1.5.1. Natural flood and erosion control

Over the centuries, floodplains develop their own ways to handle flooding and erosion with natural features that provide floodwater storage and conveyance, reduce flood velocities and flood peaks, and curb sedimentation.

Natural controls on flooding and erosion help to maintain water quality by filtering nutrients and impurities from runoff, processing organic wastes, and moderating temperature fluctuations. These natural controls also contribute to recharging groundwater by promoting infiltration and refreshing aquifers and by reducing the frequency and duration of low surface flows.

1.5.2. Biologic resources and functions

Floodplains enhance biological productivity by supporting a high rate of plant growth. This helps to maintain biodiversity and the integrity of ecosystems.

Floodplains provide excellent habitats for fish and wildlife by serving as breeding and feeding grounds. They also create and enhance waterfowl habitats and help to protect habitats for rare and endangered species.

1.5.3. Societal resources and functions

People benefit from floodplains through the food they provide, the recreational opportunities they afford, and the scientific knowledge gained in studying them.

Wild and cultivated products are harvested in floodplains, which are enhanced agricultural land made rich by sediment deposits. They provide open space, which may be used to restore and enhance forest lands, or for recreational opportunities or simple enjoyment of their aesthetic beauty.

Floodplains provide areas for scientific study and outdoor education. They contain cultural resources such as historic or archaeological sites, and thus provide opportunities for environmental and other kinds of studies.

Floodplains can increase a community's overall quality of life, a role that often has been undervalued. By transforming floodplains from problem areas into value-added assets, the community can improve its quality of life. Chicago's lakefront, Peoria's riverfront, Naperville's Riverwalk, and Lockport's historic canal district are well-known examples.

Parks, bike paths, open spaces, wildlife conservation areas, and aesthetic features are important to citizens (see Figure 1-8). Assets like these make the community more appealing to potential employers, investors, residents, property owners and tourists.

Figure 1-8: The habitat and aesthetic benefits of a riverfront can be seen in this Kankakee River park.