Flood Types and Characteristics

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Agenda

- Why study flood types?
- Characteristics of floods
- Overview of flood types and implications
- Looking forward—climate change
Why study flood types?

- Different flood sources
  - Have different risks to human life
  - Cause different types of damage
  - Have significantly different warning times
  - Require different mitigation measures

Credit: Jocelyn Augustino/FEMA (Texas)
Characteristics of Floods

- **Where**: Where does it usually occur?
- **When**: When does it usually occur?
- **Why**: Why does it happen?
- **How**: How does it impact us?
- **How Much**: How much does it impact us?
- **What**: What does it affect most?
- **Who**: Who does it affect most?
Selected Types of Floods

- Riverine Flooding
- Flash Floods
- Structural Failure or Overtopping Floods
- Urban Drainage Flooding
- Mudflows
- Coastal Flooding and Erosion
Riverine Flooding

• **Where:**
  - In and near the floodplains of rivers and creeks
  - Typically below the point of one sq mi drainage area

• **When:**
  - Following sustained rainfall across the basin
  - When upstream basins experience heavy rainfall
  - Around the time of spring snowmelt (especially with ice jams)
  - Can also occur with tidal surge upstream

Credit: Michael Rieger/FEMA (North Dakota)
Riverine Flooding

**Why:**
- Inadequate ability of river channel to convey flows
- Obstructions in the flow path (bridges, culverts)
- In-stream sediment and geomorphologic changes

**How:**
- Sustained saturation of structures
  - Structural damage
  - Mold
- Isolation of areas from emergency response
- Standing water contamination of wells and water sources
- Velocity of flow against structures in some cases

Credit: FEMA Photo/Walter Jennings (Wisconsin)
Riverine Flooding

- **How Much:**
  - One of the most common and costly disasters in the USA
  - May be short or long duration flood events

- **What:**
  - Stationary structures
  - Areas near or outside the mapped floodplain are often least prepared

- **Who:**
  - Floodplain residents
  - Near-floodplain residents
  - Impacts are wide-ranging and economic impacts may affect non-flooded areas for years

Credit: George Armstrong, FEMA (Georgia)
Flash Floods

- **Where:**
  - Hilly or mountainous watersheds
  - Fairly highly impervious watersheds

- **When:**
  - With heavy localized rainfall in watershed
  - With very short warning time (minutes)

- **Why:**
  - Watershed is too steep or impervious to slow down flow of water

Credit: FEMA Photo/Brian Hvinden (Vermont)
Flash Floods

- **How Much:**
  - Impacts tend to be geographically isolated, but very severe
  - At least 30 major examples since the 1950s

- **How:**
  - Fast-rising flood waters
  - High-velocity flood waters
  - Debris in flood flow
  - Destruction of infrastructure like bridges and culverts
  - Trapping people in vehicles

Credit: Amanda Bicknell/ FEMA News Photo (West Virginia)
Flash Floods

**What:**
- Structures close to a creek or small river
- Structures in overflow paths from creeks

**Who:**
- Unsuspecting drivers
- Elderly and those unable to evacuate quickly

Credit: FEMA Photo/Brian Hvinden
Structural Failure or Overtopping Floods

• **Where:**
  - Downstream of dams
  - In levee-protected areas

• **When:**
  - “Sunny day” failures
  - After periods of heavy rainfall in watershed

Credit: FEMA EMI Floodplain Management Course, Chapter 2
Structural Failure or Overtopping Floods

**Why:**
- Design capacity of structure exceeded
- Design of structure inadequate
- Construction of structure inadequate

**How:**
- Much like Flash Flood, but typically worse
- Effects catastrophic
- Extreme velocities
- Extreme flood depths
- High debris potential
- Little warning time
- Destruction of infrastructure like bridges and culverts

Credit: Michael Raphael/FEMA (North Dakota)
Structural Failure or Overtopping Floods

- **How Much:**
  - Large failures very rare
  - Small failures fairly common
  - May be clustered when heavy rainfalls occur

- **What:**
  - Structures in “dam failure shadow”
  - Structures in “levee protected areas”
  - Infrastructure

- **Who:**
  - Often those who feel most “protected” by the structure
  - “Residual risk”

Credit: Skoogfors/FEMA (Texas)
Urban Drainage Flooding

**Where:**
- In urban or suburban environments
- Near the street
- Near drainage channels and structures
- In the basements of houses

**When:**
- After heavy localized rainfalls
- When drainage infrastructure gets blocked
- May be worse in periods of saturation

Credit: FEMA/David Fine (Georgia)
Urban Drainage Flooding

**Why:**
- Drainage infrastructure unable to handle flood flows
  - Infrastructure undersized
  - Infrastructure sized correctly, but flood exceeds design
  - Complex interactions between structures

**How:**
- Often a very localized event
  - Single or a few houses
- In heavy rains, many points of failure

Credit: Mark Wolfe/FEMA (Mississippi)
Urban Drainage Flooding

- **How Much:**
  - Is getting worse with aging infrastructure
  - Particularly bad in older towns
  - Combined sewer communities

- **What:**
  - Single homes or small clusters of homes
  - The older part of town (often the poorer part of town)

- **Who:**
  - The unsuspecting homeowner
  - The homeowner without flood insurance

Credit: Greg Henshall / FEMA (Iowa)
Mudflows

- **Where:**
  - Steeper watersheds with poor soils
- **When:**
  - After long, soaking rains
  - With heavy rains in weak soils areas
- **Why:**
  - Ground is unstable and unable to allow flow without erosion

Credit: Laura Lee/ FEMA News Photo (California)
Mudflows

- **How:**
  - Massive debris flows
  - Very short notice (or no notice)
  - May be high velocity
  - Similar to avalanche—buries victims

- **How Much:**
  - Impacts vary widely with geography
  - Most common in Appalachians and California

Credit: Laura Lee/ FEMA News Photo (California)
Mudflows

- **What:**
  - Doesn’t require a defined channel
  - Entire mountainside may slide
  - Worsened by blocking structures

- **Who:**
  - May impact same areas over and over again

Credit: Adam DuBrowa/FEMA (California)
Coastal Flooding and Erosion

• **Where:**
  - From Hurricanes: along Eastern and Gulf coasts primarily
  - From Tsunamis: Primarily the Pacific coasts

• **When:**
  - With larger hurricanes
  - With Nor’easters
  - Spring tides & high winds
  - With earthquakes (for Tsunamis)

Credit: Dave Gately/FEMA News Photo (North Carolina)
Coastal Flooding and Erosion

**Why:**
- Sea surface bulges due to low pressure
- Sea surface bulges due to earth movement
- Wind or current-driven waves
- Massive volume of water over limited area

**How:**
- Coastal surges often relatively fast rising (hours)
- Tsunamis extremely fast rising (minutes)
- Powerful waves usually accompany
- Massive volume of water
- Impacts may extend well inland

Credit: FEMA Photo/Brian Hvinden
Coastal Flooding and Erosion

• How Much:
  - Coastal surges and hurricanes: Produces some of the most costly natural disasters in history
  - Tsunamis: Have produced catastrophic single-day losses of life in recent memory
  - Happens most years to some extent
  - Some indication surges and hurricanes may be getting worse

Credit: FEMA Photo/Casey Deshong (American Samoa)
Coastal Flooding and Erosion

**What:**
- Structures immediately at the coast most affected
  - Especially those prone to wave action
- Structures in front of dunes next most affected
- Structures below stillwater surge elevation
- Infrastructure near the coast

**Who:**
- Devastating to coastal residents
  - This group may include very rich and very poor

Credit: FEMA Photo/Brian Hvinden
Coastal Sensitivity to Sea Level Rise 2009

Figure 1.5 Shoreline change around the United States based on surveys over the past century. All 50 coastal states are experiencing overall erosion at highly variable rates due to natural processes (e.g., storms, sea-level rise) and human activity (From USGS, 1985).

For the Southeast:

- Since 1901, average fall precipitation increased 30%
- Noticeable increase in heavy downpours in many areas
- Trend towards warmer coast waters and more hurricanes
  - Expect individual hurricanes to result in more rainfall than in the past
- Total future precipitation trends unclear

Looking Forward—Climate Change

- Riverine flooding
- Flash Floods
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