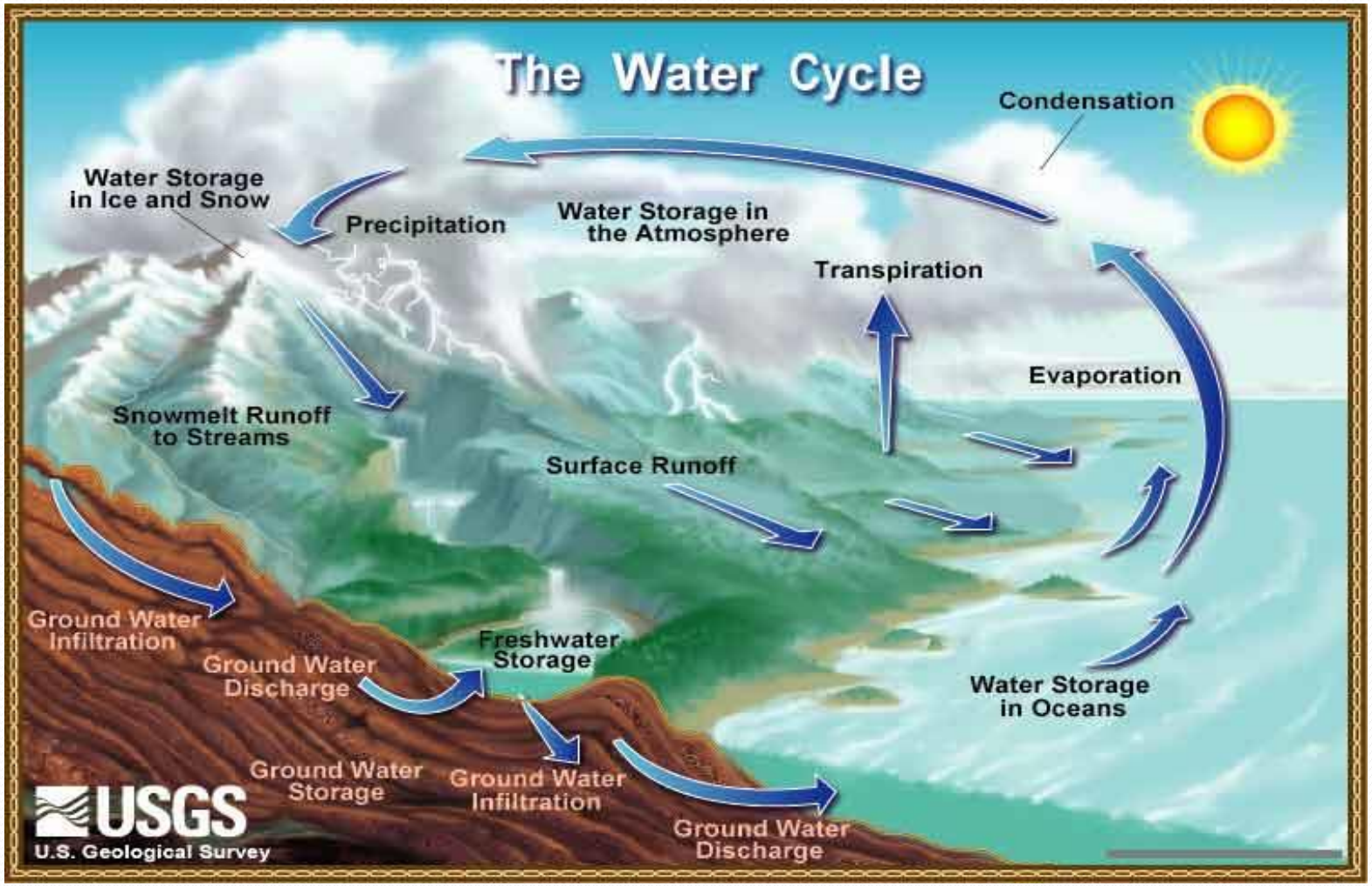
Flood Plain Management

What you need to know for the
Certified Floodplain Manager (CFM) Exam

Floods and Floodplain Management

- types of floods and floodplains
- How floods affect floodplain development
- The strategies and tools for floodplain management
- Basic terms

The Hydrologic Cycle



The Hydrologic Cycle

- When the hydrologic cycle gets out of balance, the result is a

FLOOD

Floodplain

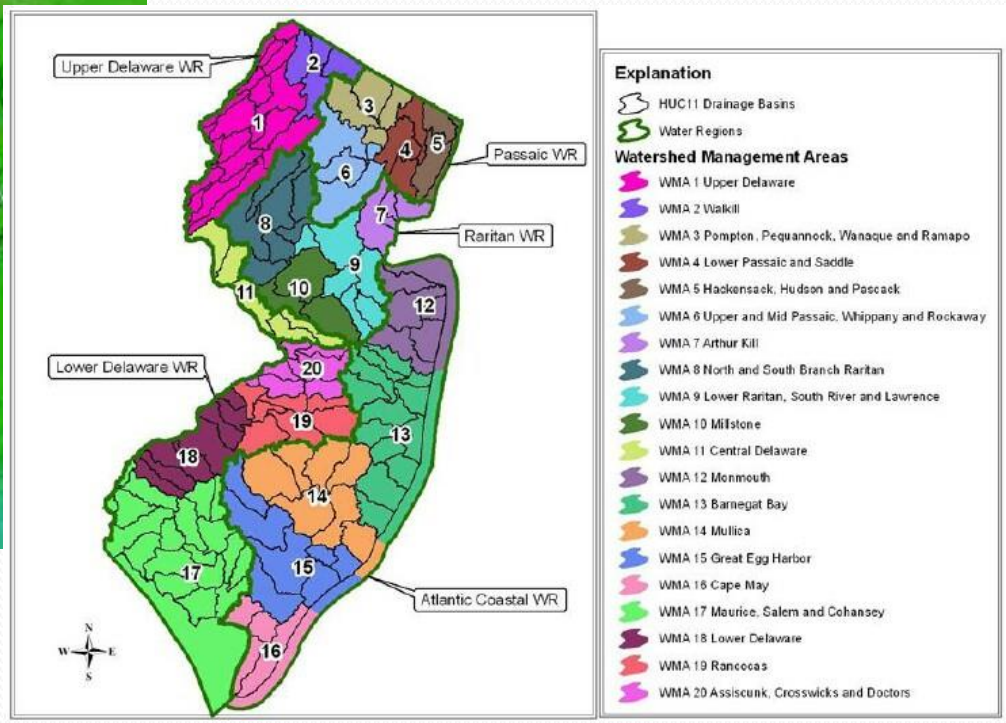
- The area that a flood inundates

- Three types:

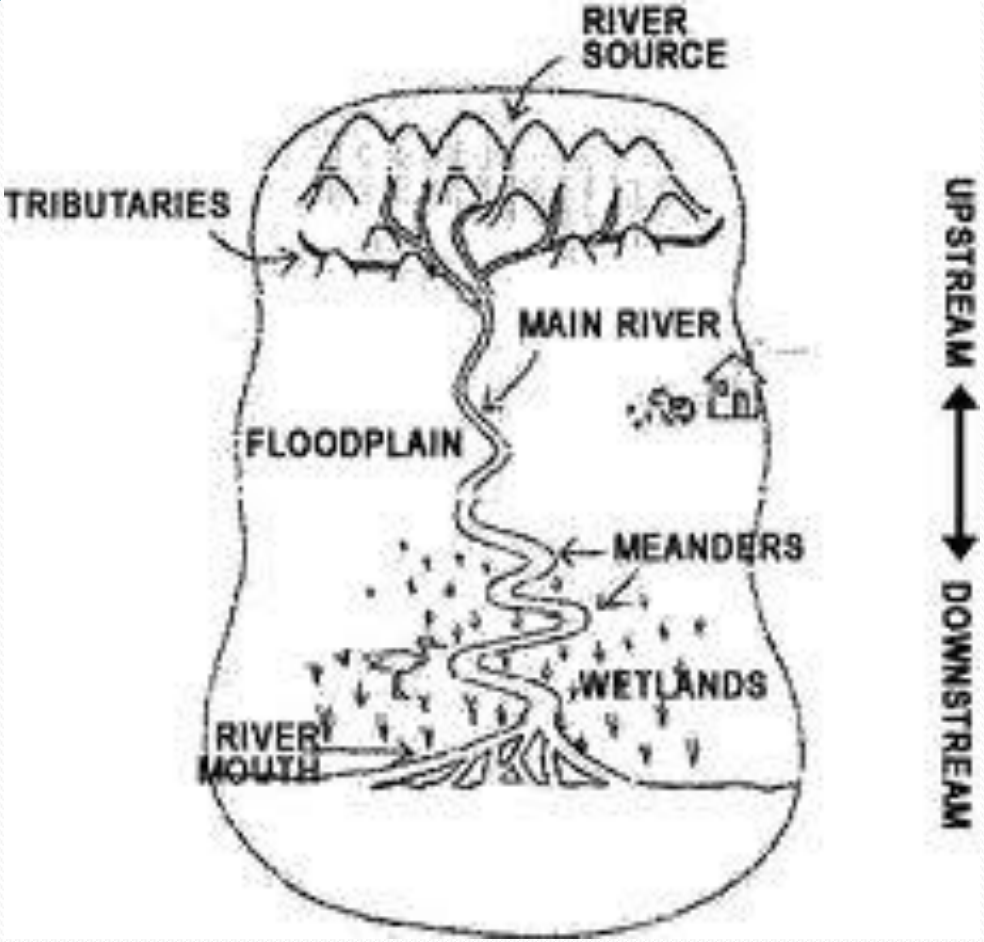
  Riverine
  Coastal
  Shallow

Riverine Flooding

- Watershed (basin or catchment area) is the land area that drains into a lake, stream, or other body of water.



Riverine Watershed and Floodplain



Ridge or Divide—the Boundary of a watershed

Channels—carry river water (rivers, creeks, streams)

Riverine Flooding is that flooding that occurs along a channel

*Flash Flood—flooding occurs a few minutes after a heavy rain

Overbank Flooding

- Most common type of flooding in the U.S.
- Overbank flooding occurs when downstream channels receive more rain or snowmelt from their watershed than normal or a channel is blocked by an ice jam or debris
- Velocity: measure of the speed of the moving water (feet/second)

Flash Floods

- Rank first as the cause of flood-related deaths in the U.S.

- https://www.youtube.com/watch?v=aZp_1KtrzjQ
- https://www.youtube.com/watch?v=cxAUoXTUtS8

- How much water does it take to get a car to float?

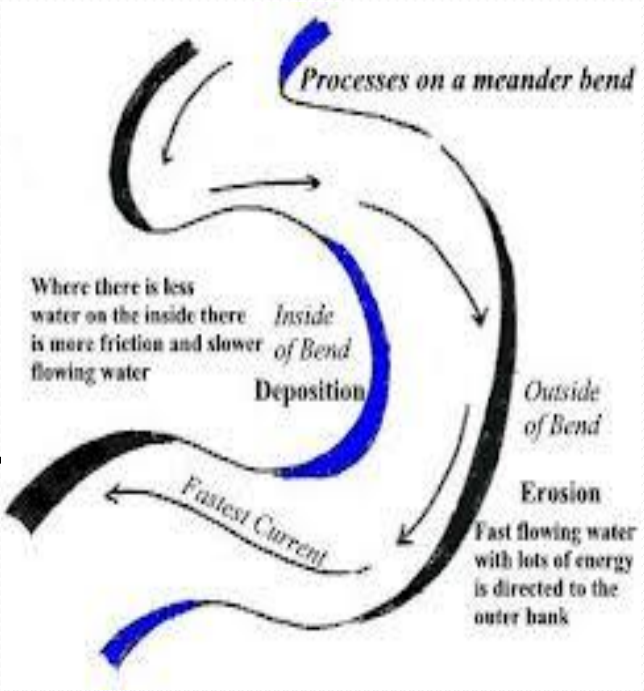
Riverine Erosion

- River channels change as the water flows and cuts new channels

- The channel bottom is the **thalweg**

and is eroded by river flow; the

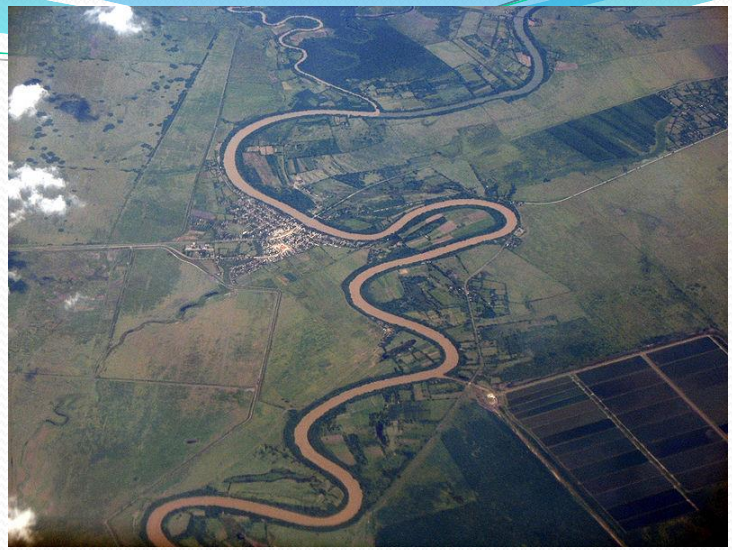
faster the flow, the greater the erosion.

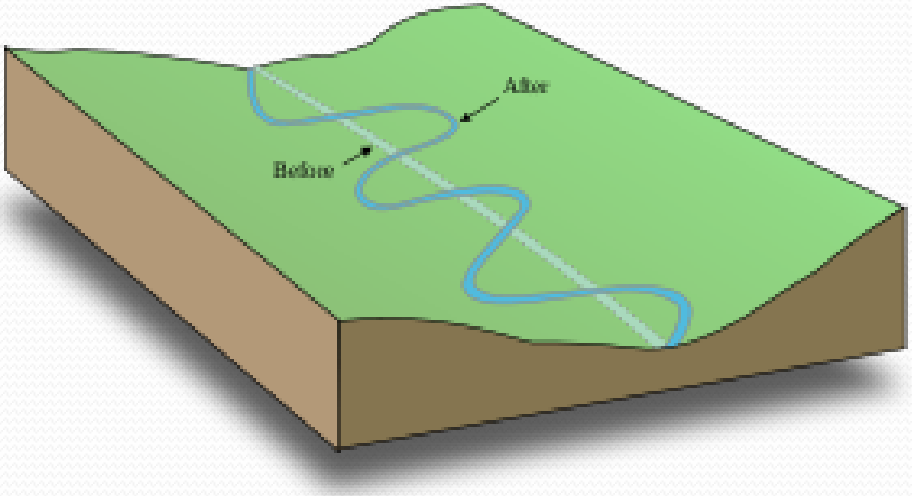


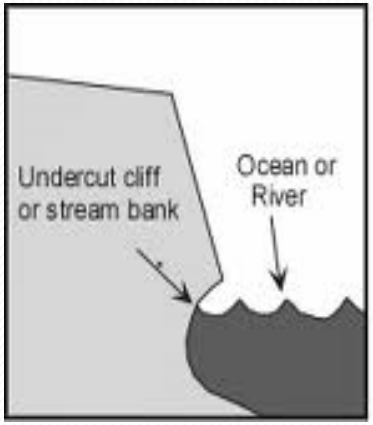
- Meanders (curves in channels)

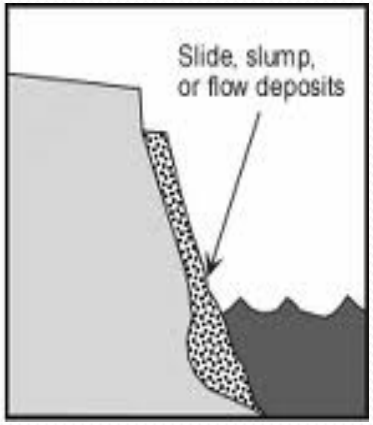
are subject to erosion on the outside areas and subject to deposition on the inside areas of the meander

Meanders




After
Before


Undercut cliff
or stream bank
Ocean or
River


Slide, slump,
or flow deposits

Coastal Flooding

- Along Ocean Coasts /Great Lakes, flooding is due to coastal storms and coastal erosion.
- The Pacific and Caribbean third hazard: tsunamis.
- Coastal Storms: Hurricanes /Nor'easters
- Storm Surge: persistent winds and pressure systems cause water levels to rise, moving water inland. Waves can be coupled with storm surge.

Tides

- The magnitude of flooding varies with tides.
- High tide, new and full moon tides, and king tides will increase flooding.
- *King tides are simply the very highest tides. The king tides occur when the Earth, Moon and Sun are aligned at perigee and perihelion, resulting in the largest tidal range seen over the course of a year. Alignments that are 'near enough' occur during approximately three months each winter and again for three months in the summer. During these months, the high tides are higher than the average highest tides for three or four days.*

Coastal Erosion

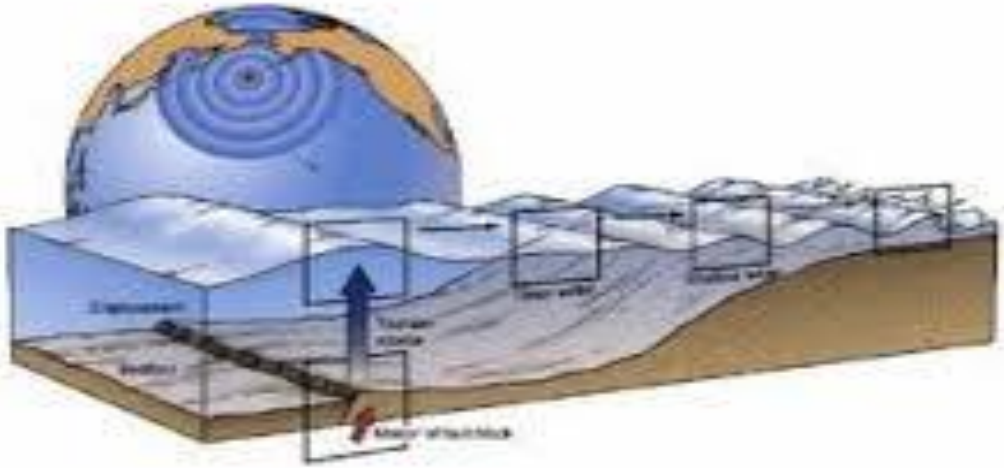
- Complex processes change the shoreline causing accretion and erosion over time.

- Human activities and development exacerbates these shoreline changes.

Tsunamis a.k.a. “tidal wave”

- Caused by an underwater earthquake or volcano

- Pressure wave that increases in energy because the energy is compressed near shore.



Lake Flooding

- Similar to coastal e.g. in the Great Lakes

Shallow Flooding- occurs in flat areas without channels and cannot drain

- Sheet flow: Water spreads out over a large area of uniform depth. Usually occurs after an intense or prolonged rainfall and water does not infiltrate the ground
- Ponding: Water runoff collects in depressions and cannot drain. E.g. glacier areas, or man-made depressions
- Urban drainage: ditches, storm sewers, retention ponds

Special Flood Hazard Areas

- Closed basin lakes
- Uncertain flow paths
- Dam breaks
- Ice jams
- Mudflows

Closed Basin Lakes

- Lakes with no outlets, e.g. Great Salt Lake
- Lakes with inadequate, regulated, or elevated outlets: e.g. Great Lakes

Seasonal rainfall fills lakes and elevated levels may remain high for months.

Uncertain (unpredictable) Flow Paths

- Flooding may change channels with each flood event.

- Alluvial fan: In mountainous areas, high velocity water picks up sediment and rock

Moveable Stream Beds

- High velocity water moves through an area with sand and loose soil and the stream channel can be lowered (degradation, filled in (aggradation), or relocated migration.

Dam Breaks

Occur for one of three reasons:

1. Foundation failure due to seepage, settling, or earthquake
2. Design, construction, materials, or operation were deficient
3. Flooding exceeds the capacity of the dam's spillway.

Ice Jams

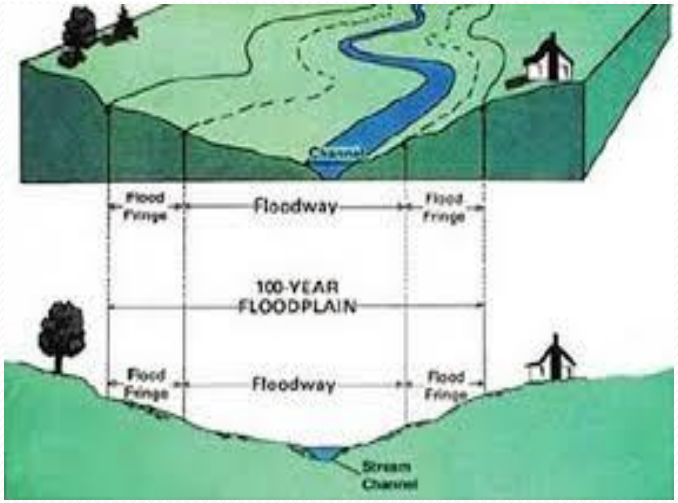
- Occur when warm weather and rain break up frozen rivers and ice jams a narrow stream channel, blocks a culvert, jams a channel bend, or blocks a bridge.

Mudflow

- NFIP defines mudslide or mudflow as a condition where a river, flow or inundation of liquid mud down a hillside usually as a result of the loss of brush cover and a subsequent accumulation of water on the round by unusually heavy rainfall.

Natural and Beneficial Floodplain Functions

- Natural flood and erosion control
- Biologic resources and functions
- Societal resources and functions

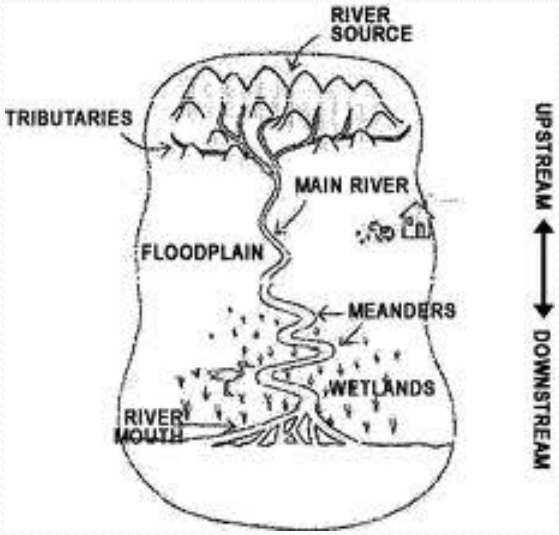


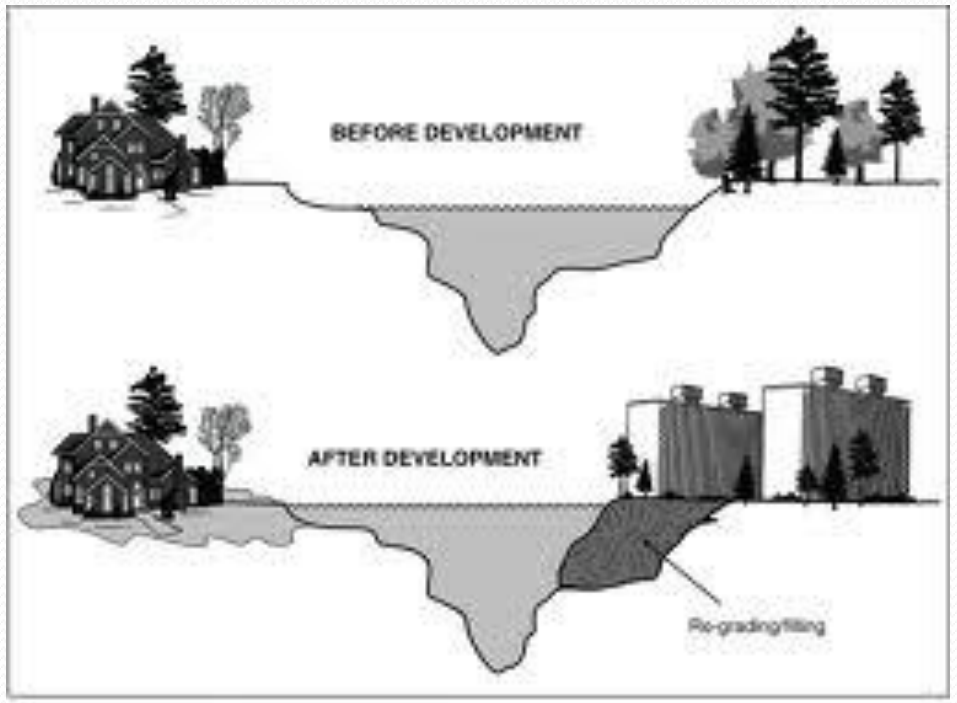
Floodplain Development

- Development alters the floodplain and the dynamics of flooding

- Buildings and infrastructure are damaged by periodic flooding

Riverine Floodplains

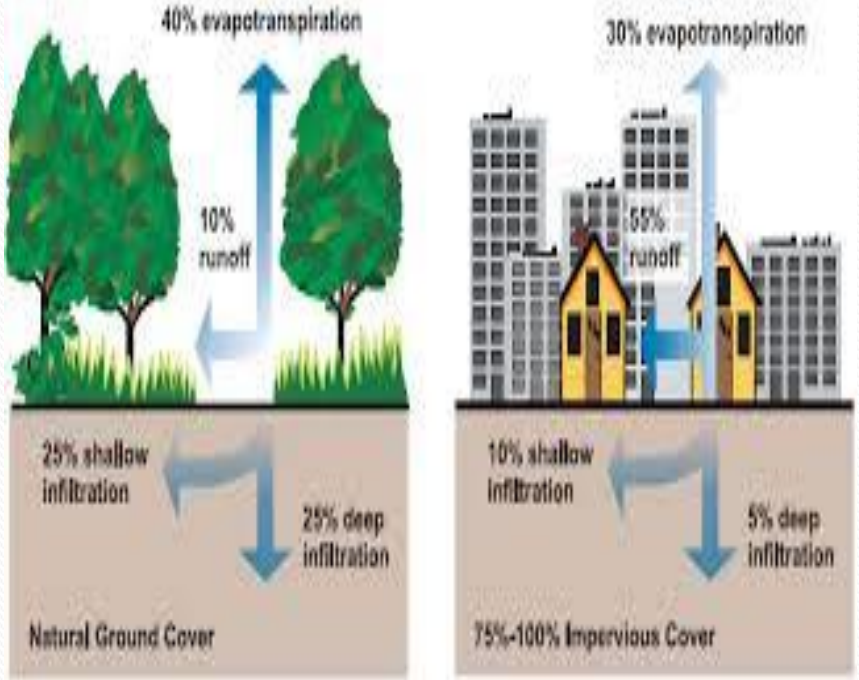


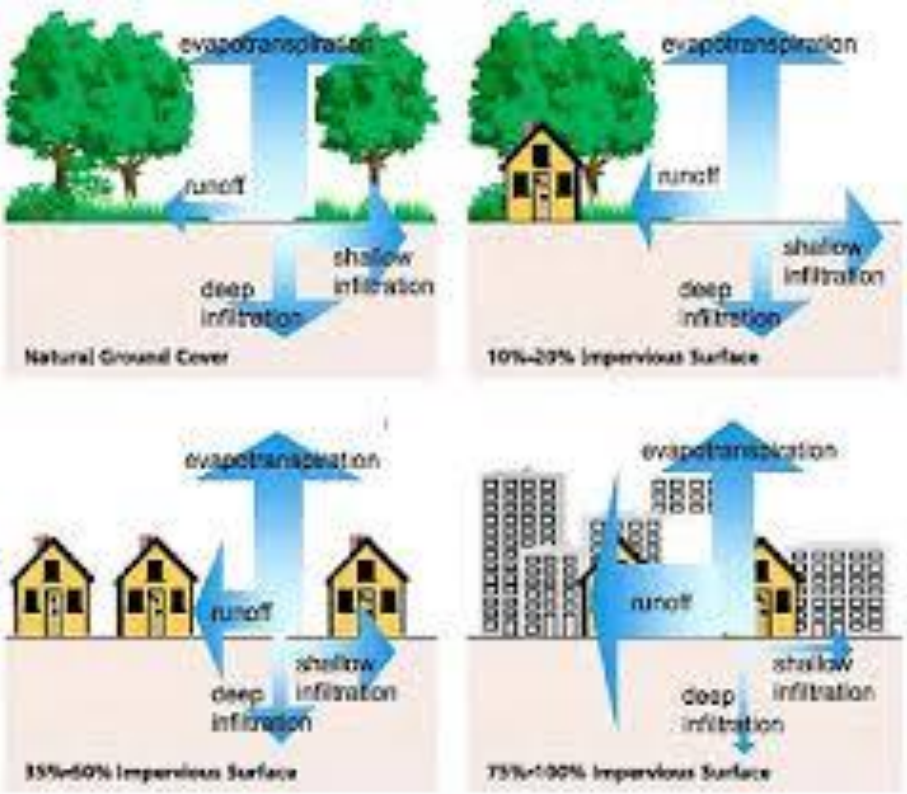


Sources: GAO analysis of FEMA data; and Art Explosion clipart.

Watersheds

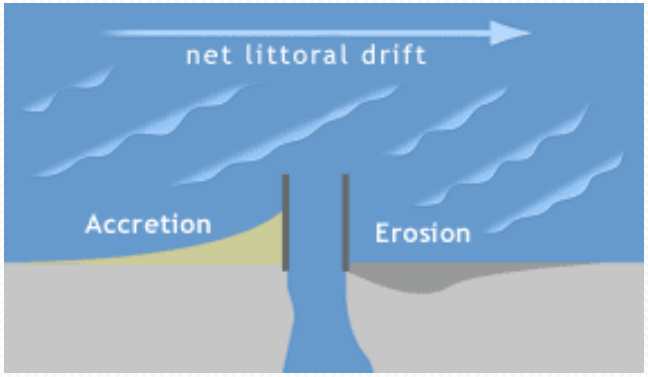
- Impervious Cover





Coastal Development

- Increases impervious cover and changes natural sand migration patterns.



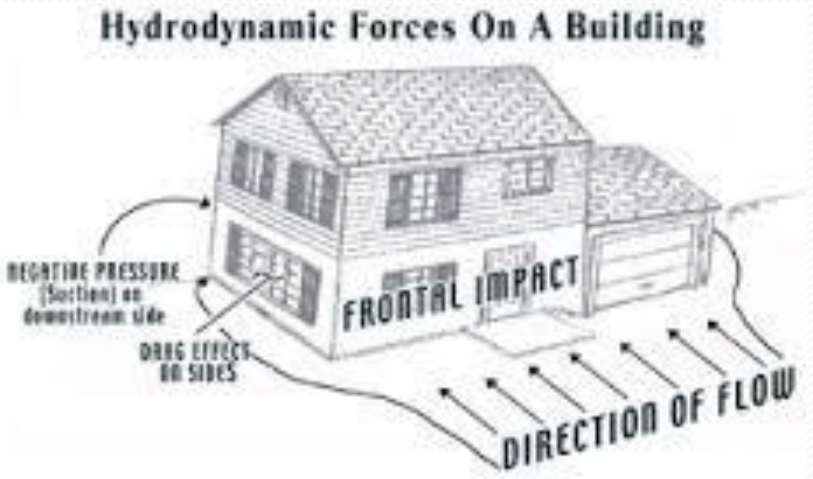
FLOOD DAMAGE

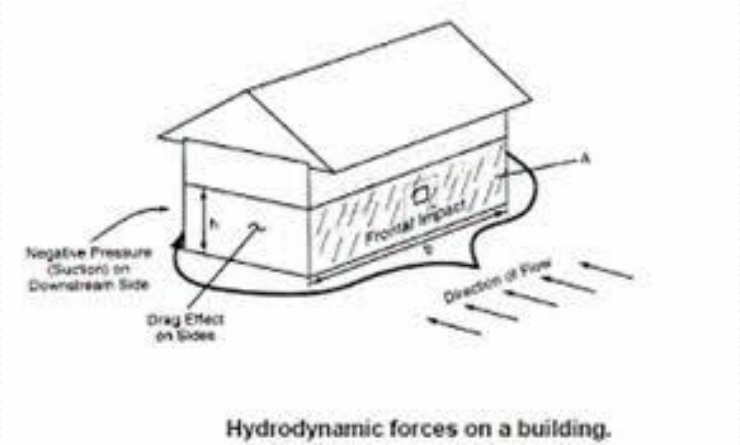
- HYDRODYNAMIC FORCES
- DEBRIS IMPACT
- HYDROSTATIC FORCES
- SOAKING
- SEDIMENT AND CONTAMINANTS

Hydrodynamic Forces

- Hydrodynamic forces are created by moving water.

- Frontal impact
- Drag effect
- Eddies or negative pressures





Hydrodynamic forces on a building.

Debris Impact

Hydrostatic Forces

Soaking

Sediment and Contaminants

Safety and Health Hazards

- Electrocution
- Fire
- Mold/Mildew/contaminants
- Mental Health

FLOODPLAIN Management

Prior to 1960's: Flood control was mainly structural, e.g. dams, levees, and floodwalls.

- NFIP was established in 1968.
- Established an insurance program as an alternative to disaster relief
- Distributed responsibility for floodplain management to all levels of gov't and private sector
- Set national standards
- Began a comprehensive floodplain mapping program.

Non-Structural Flood Protection

- Regulations to prohibit development in high-hazard areas
- Building codes
- Acquisition and relocation
- Modify or retrofit existing buildings
- Install flood warning systems
- Control stormwater runoff
- Self-help for property owners

Unified National Program for Floodplain Management

- Created under NFIP of 1968
- Provides framework for coordinating floodplain management
- Federal Interagency Floodplain Management Task Force
- Goal is to reduce flood losses and protect natural resources and functions of floodplains

Strategy 1-Modify Susceptibility

- Zoning and building codes
- Policies on design and location of public services, utilities and critical facilities
- Land acquisition
- Elevating or flood-proofing new buildings or retrofitting existing buildings
- Preparing for flooding through forecasting, warning systems, and emergency planning
- Restoration of floodplains

Strategy 2-Modify Impacts

- Provide self-help through information, education, and protection measures
- Flood emergency procedures
- Reduce financial impact through disaster assistance, flood insurance, and tax adjustments
- Prepare post-flood recovery plans and programs and mitigation measures

Strategy 3-Modify Flooding

- Building dams and reservoirs
- Build dikes, levees and floodwalls
- Alter channels
- Divert flows
- Allow for soil infiltration
- Store water with on-site detention basins
- Shoreline protection measures
- Control runoff from areas outside floodplain

Strategy 4-Preserve and Restore Natural Resources

- Develop land use regulations that direct development out of wetlands and floodplains
- Land acquisition and open space preservation
- Information and education on importance of floodplains
- Tax adjustments as a financial incentive for preserving lands or restoring to natural state
- Beach nourishment and dune building