**lecture 6, 10/20/08**

## Part I - River Flooding cont'd

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***Sources***

**Chapter 14 - Floods** (regional floods, societal response, urbanization) (pp. 395-408) and http://myweb.cwpost.liu.edu/vdivener/notes/streams_22.htm

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## River Flooding

***Regional Flooding***
long lasting flooding due to many days or weeks of rain over a large area
water collects over large network of streams
flood discharge (hydrograph) builds gradually to very high peak discharge
slow (weeks) decrease of discharge after peak as water comes down far-flung network

***1993 Mississippi-Missouri River Flooding***
a longstanding weather pattern
    southerly course of jet stream guided low pressure systems across upper midwest
    high pressure on east coast pumped warm, humid air off Gulf of Mexico
produced flooding of streams across upper midwest, upper Mississippi basin
MAJOR flooding on Mississippi & Missouri Rivers as water moved down tributaries

    48 died
    75 towns submerged
    50,000 homes destroyed or damaged
    12 airports closed
    4 interstate highways closed
    $12 billion in damage

***levee breaks***
many artificial levees, built to protect against flooding, broke in the 1993 flooding
levees wash out rapidly if water overtops and starts to flow over a levee
Mississippi discharge decreased briefly following each levee break
    as water flooded out of river onto floodplain behind levee
    but overall, floodwaters kept rising

peak flood stages (highest water mark) on the Mississippi rose greatly during the 20th century as a result of the building of levees
levees prevent the numerous small floods but don't protect against, actually worsen, the large floods

levees confine floodwaters in a stream's channel, preventing water from spreading out in a flat sheet across the floodplain, resulting in floodwaters becoming much higher than they otherwise would in the channel resulting in major flash flood damage locally where levees broke

as the 1993 flood gradually subsided the levees prevented floodwaters from draining off the floodplain and back into the river resulting in extended flooding across the floodplain

levees prevent sediments from being deposited across floodplains in floods

sediments build up in the stream channel, raising streambed and the stream height

New Orleans, and Louisiana has been trying to hold the Mississippi in place for centuries. as a result, the Mississippi River stands up higher than the surrounding areas, including New Orleans itself due to the buildup of sediments deposited in the channel. One day it will break out and take a new course (probably via the Atchafalaya River, upstream from New Orleans).

***urbanization of floodplains***

we have built cities on floodplains because:

- they are natural corridors for transportation
- floodplain alluvium makes for fertile cropland
- flat land to build on
- source of fish (food, industry)
- source of water
- modern values: scenic, recreational

***urbanization and flooding***

however, urbanization affect stream characteristics

- pavement and buildings covers formerly vegetated areas
- decreased area for infiltration, less vegetation for evapotranspiration
  - result: more runoff into streams
- increased smoothness of surfaces plus storm drains connected to streams
  - result: faster runoff into streams

***urban flash floods:*** streams in urbanized areas have greater peak flood discharges and the peak discharges occur sooner, compared to the way the streams behaved before urbanization

***flood frequency*** is greater as well, since smaller rains produce large discharges

**Societal Response to Flooding**

***structural methods***

- levees (see above)
- sandbagging (temporary levees)
- channelization (see below)
- dams
  - hold back water in reservoir during rising flood discharge
- watershed maintenance
  - gully control, revegetation of slopes (slow the movement of water down slopes)
- raise houses on berms or stilts
- artificial recharge basins/retention ponds/sumps
  - collect urban runoff to allow slow infiltration and reduce discharge on streams
  - often required for new construction projects

***non-structural methods***

- forecasting
  - both for weather and timing of peak discharge/max water height
- zoning and land use
  - limit building in floodplain
- insurance
  - spread out cost or rebuilding over time and over the entire population
- Presidential Disaster Declaration
  - a national form of insurance, everyone helps to bail out the victims
- flood warning system

***channelization***

to prevent flash flooding on urban streams they have commonly been modified

- widening & deepening allows them to hold more discharge in channel
- straightening increases the gradient allowing them to flow faster
- smoothing (lining with concrete) allows them to flow faster

***benefit:*** these allow storm discharge to flow away quickly thereby preventing or diminishing flooding of nearby roadways and buildings

***negative impacts:***

- ugly: the natural beauty of the stream is gone
- costly to build (and maintain)
- destroy habitats and biodiversity
- increasing flood risk downstream

***Tijuana, Mexico - south San Diego, California***

Tijuana and San Diego agreed to channelize a stream running from Tijuana into southernmost San Diego. Tijuana built a broad, deep concrete channel, but San Diego decided to go environmental and leave their portion of the stream natural. Result: flood waters rapidly flow out of Tijuana and pile up in fields of southern San Diego.

***San Diego River, San Diego***

The San Diego River flows through San Diego to the Pacific Ocean. It is naturally about 25 feet wide. The western end of the river leading to the Pacific was widened to ~800 ft by the Army Corps of Engineers in the 1940s. The Central section has been left largely in a natural state. The eastern (upstream) section was channelized (as a result of commercial pressure) with a width of ~360 ft. The eastern channel can hold a peak discharge of 49,000 $ft^3$/sec. But it flows into the natural central channel that can only contain a peak discharge of 8,000 $ft^3$/sec.

Result: the central section floods due to rapid, high discharge from the east section.

***Tuscon, Arizona, October 1, 1983***

- a very rainy September was followed by Tropical Storm Octave
- peak discharge was 1.76 times the predicted 100 year flood
- but 6 of the 7 largest floods in Tuscon happened between 1960 & 1983
- urbanization tripled the size of the 100 year flood (officials forgot to recalibrate)
- protective barriers on stream banks were inadequate
- 13 people died overall
- 30 mobile homes washed away on the outer bank of a bend in Pantano Wash