Hydrologic Hazards of the Earth's Surface

2002 Eastern European Flooding along Danube

Geologic agents shape the Earth: rivers, mass wasting, glaciers, wind, underground water and waves
>river flooding may be the most globally pervasive

Hydrology: science that deals with liquid and solid global water, its properties, circulation and distribution on Earth and in the atmosphere.

River Systems

A stream's ability to erode is a function of velocity and discharge

Factors important in river systems:

1) Velocity (V, in ft/sec)
2) Discharge (Q, in cfs or cubic feet per second)
3) Cross-sectional area

Increased discharge and velocity increase the stream's erosive potential.

Gradient: longitudinal profile of a stream channel
>expressed usually in feet per mile
>steepest gradients are near stream beginnings, shallowest near mouth

Base Level: lowest level to which a stream can erode
>typically near sea level

Floodplain: typically near base level. The flat area in the lower reaches of the river.
>Floodplains produce "bottom lands", productive clay and silt soils (due to slower velocities found near base level)

Stream Features

Alluvium: sediment deposited by running water

Alluvial Fans: sediment deposits found at the base of mountains above streams that open onto flat valley floors

Delta: similar to alluvial fans in shape and process, but in this case they streams open into a standing body of water, such as a lake or ocean
>Herodotus: used to describe them the greek letter delta
>Prone to coastal flooding, the most dangerous natural disaster
(500K dead in Bangladesh in 1970)

Meander: sinuous curve made by a river
>after Menderes River in Turkey

Point Bar: deposits produced on the inside of a meander

Meander Cutoffs and Oxbow Lakes: shortcut take by a river that cuts off a loop or meander

Natural Levees: sediments deposited on the flanks of a river

Artificial Levees: produced by us to control water flow

Levees of both types can protect cities.
>St. Louis, Johnstown

When There Is Too Much Water

Drainage Basin: the land area that contributes water to a particular stream or stream system

Drainage Divide: high point or ridge that separate drainage basins

Factors Determining Flooding:
1) intensity of rainfall
2) amount of prior rainfall
3) amount of snowmelt
4) Topography
5) Vegetation

Flash Floods: upland floods in moderate to high relief areas
>typically fast and furious

Rivernine Floods: flood plains are inundated by rising waters

Hydrograph: graph of a water body's discharge
>flooding is predictable to a degree

Flooding is the #1 loss of life
>coastal areas the greatest
>noncoastal are due to dam breaks
1) 1889 Johnstown Flood
2) 1928 St. Francis Dam

Flood Measurement

Large drainage basins have greater potential for huge floods
>Just like faults!!!

Bank Full Stage: channel fills with water

Flood Stage: river water spills onto flood plain

Stage Hydrograph: relates steam discharge to river height (Figure 9.13)

Flood Frequency or Recurrence Interval

>How often on average a flood of a given magnitude can be expected in a particular location

Info needed: long term annual peak discharge (Q)

T (RI)=(N+1)/M Where: N=number of years of records
M=rank of event

If 100 years of records are available, the largest flood would be #1 or the "100 year flood".

>100 year event: 1% chance, 50 year even: 2% chance
>statistical probability: not an exact time table
>Use Figure 9.17 to predict building life: essentially a gamble
>human involvement and building can alter predictability, and so can climate change…

The Flood of 1993

>48% of rain ends up in the Mississippi River
>wet spring and a rainy July and August
>10-12 billion in damage
>broke record high water make in St. Louis July 19 (46 ft), July 20 (47.1 feet), and on August 1 (49.4 feet)

Mitigation Options

1) Dams: The Solution or the Problem
    a. Lower 48: 75K dams
    b. Now no longer make them
    c. Dams slow water flow, increase sedimentation rates
    d. Nowadays try to make dams ecologically better, especially for critters like spawning salmon
    e. 1996 Federal Law: requires environmental concerns be addressed before relicensing of a dam
    f. Move has been to remove dams, but the bodies of water behind the dams have created their own ecosystems

2) Artificial Levees: The Solution or the Problem
    a. Floodplain development in response to human construction has driven up property values
    b. Many artificial levees were created to protect farmlands, but those farms were replaced by urban developments. Unfortunately the artificial levees were meant to protect the farms, not the urban areas
    c. The buck gets passed, like in Johnstown
    d. Artificial levees are thus self perpetuating
    e. Floodwall construction – inside artificial levee, as in near the old French Quarter of New Orleans

3) Insurance, Flood Proofing and Floodplain Management
    a. National Flood Insurance Act of 1968 – federally subsidized insurance protection in flood plain areas
    b. 100 year flood level is the Regulatory Floodplain
    c. Pre-1968 houses are protected
    d. Always folks looking to take advantage

Methods of Flood Proofing

1) Raising structures above 100 year flood levels
2) Building walls and levees to resist floodwaters
3) Using water resistant building materials

Alluvial Fans can be difficult to manage

>Palm Springs and here, CA

Urbanization causes floods to peak sooner

>100 year floods become 70 or 80 years

>Johnstown

>"Floods are an act of God. Floods damages result from acts of men."

When There Is Too Little Water

>Southwest especially

>2002 – record drought

*Colorado River – 85% lower (100 year low)

*Rio Grande did not reach the Gulf of Mexico

>Water diversion and agricultural use are also part of the problem

>PDO – Pacific Decadal Oscillation (20-30 year interval)

*Not sure if it is real yet

Flood Facts and Flood Planning

1) Floods are the most consistently destructive natural hazards
2) Floods cannot be controlled completely, but can be mitigated somewhat
3) Flood-damage costs have been increasing at a rate of 5% annually
4) Urbanization increases flood peaks of small streams by 2 to 6 times
5) Use of the 100 year flood standard for regulation has been useful, but new research indicates climate change should be an included parameter
6) Do not drive through floodwaters! (figure 9.25)

Case Studies

9.1: The Nile River

>Measurement of Nile floods go back as far as 1750 B.C. (some say longer)

>Aswan High Dam changed things in 1970

>Schistosomiasos – parasitic disease

>Shrimps left the delta area

9.2: Water, Water, Everywhere

>New Orleans – highest level of land 5ft (levee)

1) Average elevation: 1.3 ft
2) Lowest: drained wetlands 2 meters below sea level (Including French Quarter)
3) Subsidence from sediment and urbanization

9.3: Dams – No Longer In

>Three Gorges Dam Vogue

>24 billion

>US – the days of big dams are over

9.4: Rivers, Gorges and National Parks

>Yellowstone – the first, 55th: Black Canyon National Park (2002)