GLY1010
Introduction to Earth Sciences

Lecture 16: Rivers and Flooding

Reading: Ch 16: Pg 467-501

Cell Phones Off

River Systems: Key Points

- Rivers transport water
- Rivers transport sediment *(load)*
- Rivers do geologic work
  - Erosion
  - Deposition
    - » Landform construction
  - Processes related to the work of rivers and streams are known as *Fluvial* processes
- A river's ability to transport sediment and do geologic work controlled by:
  - Total volume of water flowing in stream
  - The velocity or energy that the water is moving with

Volume of Water Flow

- Water volume per unit time: *Discharge*
  - Q = Cross Sectional Area * Water Velocity
- Controlling Factors:
  - Size of drainage basin (watershed)
  - Shape of the stream
  - Climate
  - Vegetation
  - Surface geology - controls infiltration
- In general discharge increases down stream
  - Larger drainage basin
- Examples:
  - Small stream: 1 - 1000 m^3/s
  - Mississippi River: 5,000 - 200,000 m^3/s

Drainage Basins

- The catchment area contributing to a stream at a given point
  - The *watershead*
- Individual basins separated by drainage divides
  - Ridge or highland that water doesn't flow across
- In general, the larger the drainage basin, the larger the discharge in a stream

Velocity of Water Flow in a River

- Controls erosive energy and sediment competence
  - Kinetic Energy = $1/2mv^2$
- Controlling factors:
  - River gradient (slope)
    - » Gradient & energy decrease downstream
  - River depth
    - » Deep rivers have less friction and faster velocities
  - River width
    - » Rivers must flow faster in narrow regions
  - River shape
    - » Water must flow faster on outside of curves

Sediment Transport: Load

- *Load*: quantity of material transported by river
- Dissolved load
  - Dissolved ions, products of chemical weathering
- Suspended load
  - Smaller, lighter particles suspended in water
  - Give rivers muddy cloudy appearance
- Bed load
  - Larger, heaver particles moved by rolling and sliding

Sediment Transport: Capacity and Competence

- **Capacity: total sediment load carried by flow**
  - **High discharge rivers have high sediment capacity**
  - **The largest rivers carry the most sediment**
- **Competence**
  - **Measure of the largest particle size a flow can carry**
  - **Controls *sorting* of sediments**
  - **Water velocity (e.g. Energy) controls competence and erosive power**
- **Examples:**
  - **Lower Mississippi River**
    - » **Large drainage basin -> high discharge**
      - **High capacity**
    - » **Low velocity -> low energy**
      - **Low competence**

Dynamic Equilibrium and the Longitudinal Profile

- **Graph of stream elevation verses distance from head is concave upward**
  - **Stream gradients decrease down stream**
  - ***Graded stream***
- **Reflects *dynamic equilibrium* between tectonic uplift, erosion, transport, and deposition**

Base Level

- **Lowest level of longitudinal profile**
  - **Stream gradient approaches zero**
- **A river cannot cut below its base level**
- **Typically at mouth of stream at lake or ocean**
  - **Loss of competence results in deposition of a delta**
- **Global ("ultimate") base level is sea level**
- **Raising or lowering base level will cause the river's longitudinal profile to change until a new equilibrium is established**
- **Examples**
  - **Raising and lowering of sea level**
  - **Building of dams**
  - **Draining of lakes**

River Valley Morphology

- **Steep, narrow "V shaped" cross section in upper reaches**
  - **Rivers are actively down cutting**
  - **Rivers tend to be relatively straight**
- **Broad valleys and Floodplains on lower reaches**
  - **River channels migrate across floodplain**
  - **Overflow banks during floods and deposit sediment on floodplain**
  - **Rivers follow curves called *Meanders***
  - **Floodplains contain rich soils and have been utilized for agriculture since ancient times**

Floods

- **A stream will overflow if discharge exceeds the capacity of its channel**
- **Occur in response to high rainfall or snowmelt**
- **Size quantified by discharge or *stage* (height of river)**
  - » **Time of peak discharge or stage is the *crest***
- **Frequency quantified by *recurrence interval***
  - ***Average* period over which flood of given size will occur**
  - **E.g. 50 year flood, 100 year flood, etc.**
    - » **There is a 1 % probability that a 100 year flood will occur in a given year**
- **Natural part of a river system**
- **Worldwide, floods produce the greatest loss of life of any natural hazard**

Types of Floods

- **Regional Floods**
  - **Occur over large area of drainage basin due to precipitation or snow melt over wide area**
  - **Can affect areas far downstream from source of the water**
    - » **Downstream floods**
  - **Can often be forecast**
- **Flash Floods**
  - **Affect relatively small area with little warning**
  - **Caused by intense rainfall over short period**
  - **Can be worsened in urban areas by increasing runoff**
- **Ice-Jams**
- **Dam-Failure**

Flood Control

- **Engineering Efforts**
  - **Artificial Levees**
  - **Dams**
  - **Channelization**
- **Non-structural Flood control management**
  - **Smart planning and zoning practices**

Key Terms for Review

- **Alluvial Fan**
- **Alluvium**
- **Base level**
- **Bed load**
- **Capacity**
- **Competence**
- **Discharge**
- **Dissolved load**
- **Drainage divide**
- **Drainage basin**
- **Flood**
- **Floodplain**
- **Graded stream**
- **Gradient**
- **Longitudinal profile**
- **Meander**
- **Natural levee**
- **Oxbow lake**
- **Point bar**
- **Recurrance interval**
- **Return period**
- **Saltation**
- **Settling velocity**
- **Sorting**
- **Suspended load**

Next Time

- **Groundwater**
- **Ch 17, PG 503-529**