# Geog 1000 - Lecture 20

## Fluvial Geomorphology

http://scholar.ulethbridge.ca/chasmer/classes/

## Today's Lecture (Pgs 353 – 369)

1. Assignment 3
2. Review of Discharge
3. Stream hydrograph
4. Stream erosion, sediment transport
5. Stream channel erosion, gradient, deposition
6. Stream and river landforms
7. Floods and flood management

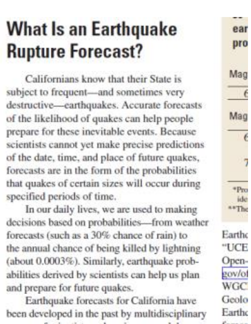
Also, we are setting up a Remote Sensing Society (satellites, NASA, etc.) in Lethbridge. If interested check out: www.crss.sct.ca → will be focused on student events.

Also NASA Tournament Earth to select best satellite image of the year (on same website).

## Assignment 3

Forecasting California's Earthquakes – What can we expect in the next 30 years?

*1. Mapping probabilities or 'forecasts' is an important method used for estimating where an earthquake might occur in the future. Describe what is meant by 'probability' (using either this article or another source) (4 marks) and relate this to another naturally occurring event (2 marks). Please state your source for information if you use additional literature. Total = 6 marks.*



**What Is an Earthquake Rupture Forecast?**

Californians know that their State is subject to frequent—and sometimes very destructive—earthquakes. Accurate forecasts of the likelihood of quakes can help people prepare for these inevitable events. Because scientists cannot yet make precise predictions of the date, time, and place of future quakes, forecasts are in the form of the probabilities that quakes of certain sizes will occur during specified periods of time.

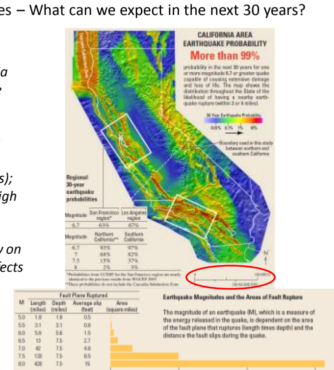
In our daily lives, we are used to making decisions based on probabilities—from weather forecasts (such as a 30% chance of rain) to the annual chance of being killed by lightning (about 0.0003%). Similarly, earthquake probabilities derived by scientists can help us plan and prepare for future quakes.

Earthquake forecasts for California have been developed in the past by multidisciplinary

## Assignment 3

Forecasting California's Earthquakes – What can we expect in the next 30 years?

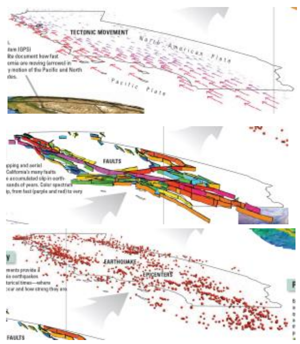
*2. Using the map on Page 1: California Area Earthquake Probability, describe areas of high vs. low probability: a) where do we find areas of greatest probability and lowest probability for earthquakes using north, south, east, west, centre, etc. descriptors (4 marks); b) in which direction do the lines of high probability for earthquakes occur (1 mark); c) do you think that living between the areas of high probability on the map will exclude you from the effects of a magnitude 5 earthquake? What about a magnitude 7.0 earthquake (why/why not)? (5 marks). Total = 10 marks*



## Assignment 3

Forecasting California's Earthquakes – What can we expect in the next 30 years?

*3. a) Using the vector (arrow) map on pg 2, and the fault map extending from pages 2-3, describe the relationship between tectonic movement (velocity) and the formation (or lack thereof) of fault lines (6 marks). b) Using these maps, why do you think that the greatest probability for a magnitude 6.7 occurs in the southern part of California (4 marks)? c) Where did most of the earthquakes occur in the past in California (e.g. describe clusters of epicenters on the Seismology map, relative to their north, south, east, west, centre, etc. locations and fault lines) (4 marks). Total = 14 marks.*




## Review of Stream Discharge (Q)

What is it?

*Movement of water downslope → influenced by gravity*

→ Contains an amount of *kintetic* energy
→ provides a certain amount of water
→ shapes the stream and surrounding land surface (geomorphology)

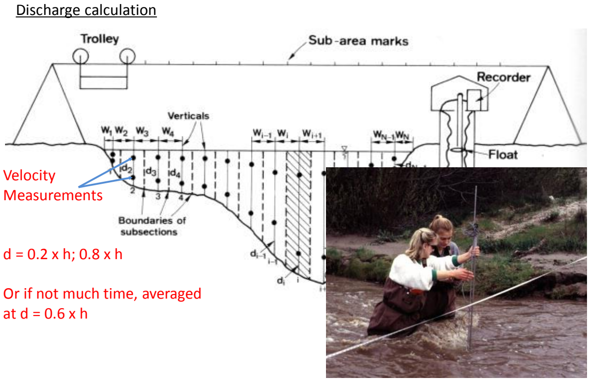
Defined as: Rate of flow of water volume (including sediments etc.)
Units = volume length of travel per unit time (e.g. $m^3 s^{-1}$).

$Q = A \times V = W \times D \times V$

Q = discharge $m^3 s^{-1}$; A = area; W = channel width
D = avge channel depth; V = avge stream velocity

## Determining discharge from transects:

Discharge calculation




Velocity Measurements

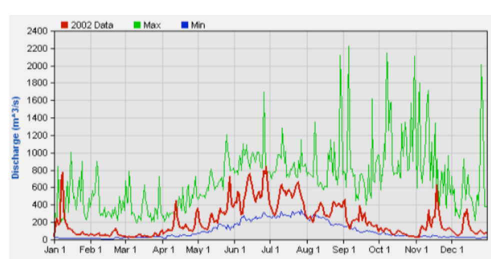
d = 0.2 x h; 0.8 x h

Or if not much time, averaged at d = 0.6 x h

## Discharge can vary in space and time:

Discharge is spatially and temporally variable. Why?

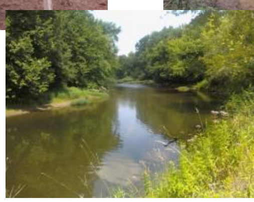
1. Size and shape of the watershed
2. Basin geology, permeability of rock types
3. Differences in vegetation type, structure…
4. Precipitation, type, distribution…



## Discharge alters the ‘existence’ of streams

Intermittent streams: flow from weeks to months each year – some groundwater


Ephemeral: flow after precipitation events, not connected to ground water



Perennial: Flow all year, fed by ground water, rainfall and snowmelt

## Exotic Streams

Often found in arid areas: Discharge *decreases* with distance due to high evapotranspiration, water use.

*Example: Colorado River http://www.nationalgeographic.com/americannile/*

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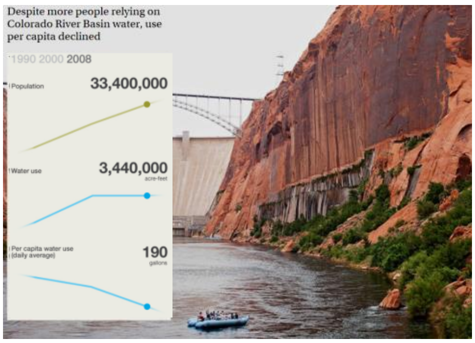
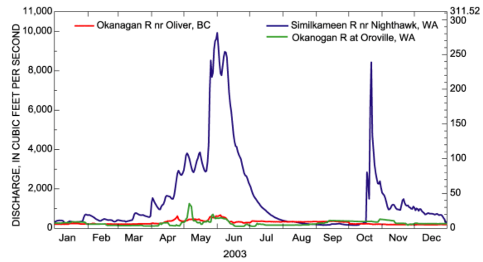



## Stream Hydrograph

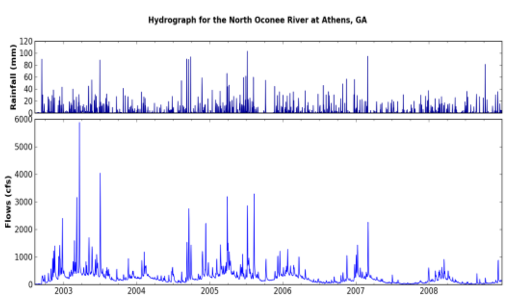
*Hydrograph: A graph of discharge over time, often with graph of precipitation.*

Hydrographs comparing different rivers in BC and Washington State.



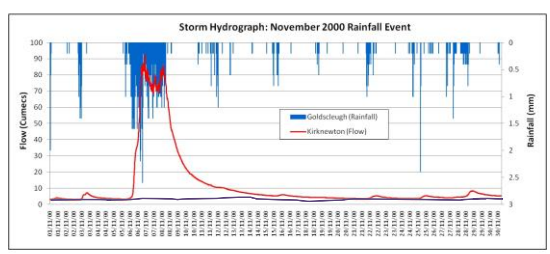

## Stream Hydrograph

Response of a river hydrograph over several years with precipitation.



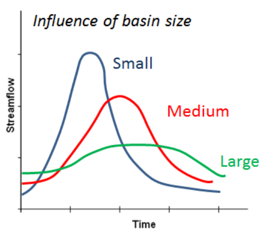

## Stream Hydrograph

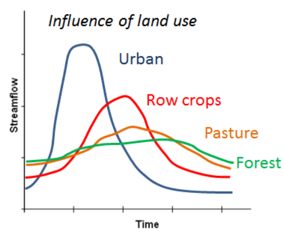
Single event response of a river following a large rainstorm – Note the lag…




→ Baseflow from groundwater usually occurs when precipitation is minimal

# Basin factors affecting the Hydrograph




# Why Analyse Hydrographs?

*Important for:*

1. Water supply → Excess P is water resource used by humans.

2. Flood prediction, forecasting → Flood prediction in engineering, land use planning and regulation.

3. Water quality → Strongly influenced by chemical/biological reactions as water flows to channel.

*** There are many different types of hydrographs:*

→ Storm Hydrograph – water level, discharge of river

→ Subsurface Hydrograph – water level of wells in aquifer

→ Water chemistry Hydrograph – contaminant flow in rivers following spill

Etc.

# Fluvial processes

*Fluvial Processes → Stream transport of sediment, deposition, and erosion of stream banks.*

These produce *fluvial* landscapes.

Some examples:

# Stream Erosion

*Streams carve out the landscape through erosional turbulence and abrasion.*

*Hydraulic action* → Erosion due to flowing water only.
*Abrasion* → Debris movement, particles grinding out the stream bed

Hydraulic action is greatest in upstream tributaries (at highest elevations)

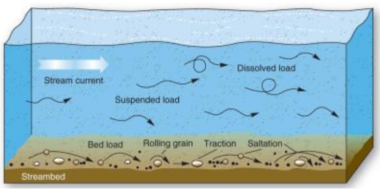
Abrasion from debris movement, suspended sediments is greatest downstream.

## Sediment Movement through Streams

*Dissolved load* → dissolved in water

*Suspended sediment load* → fine grain suspended particles (clastic, rock) in water column. Turbulence keeps particles suspended.

*Bed load* → coarse materials dragged through stream channel, supported by bed
*Saltation/traction load* → coarse materials that bounce along channel bottom




*Competence* → *ability to move particles of a given size. Requires energy.*

*Capacity* → the total possible load that a stream can transport.

## Flood Influence on Sediment Transport

*Flooding* → *May result in massive amounts of sediment movement.*
→ Stream energy is enhanced.

*Aggradation* → Build up and deposition of sediments in stream channel (clay, silt, sand, gravel, etc. deposited by running water = alluvium).

Can create a *braided* stream pattern.

## Estimating Volume of Sediment Transport

$Q_s = C_oQ$

Where $C_o$ is the concentration of suspended sediments (usually in mg $L^{-1}$)

→ convert to volume (e.g. kg $m^{-3}$ = $C_o$ x 0.001)

*Gives kg $s^{-1}$ of suspended sediments flowing through channel.*

<u>*Calculate*</u>
- *Per minute (x 60)*
- *Per hour (60 x 60)*
- *Per day (60 x 60 x 24)… etc.*

Fraser River has average $C_o$ of 186 mg $L^{-1}$ (spring); Q = 3500 $m^3$ $s^{-1}$

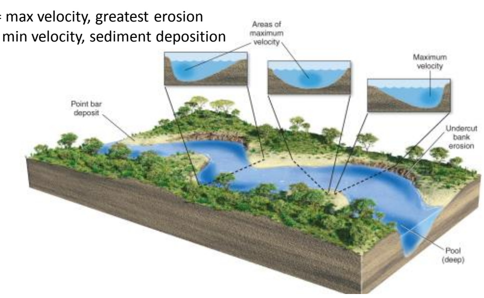
$Q_s$ = 0.186 x 3500 = 650 kg $s^{-1}$

or ~20 billion kg $yr^{-1}$

## Meandering Stream Channel Formations

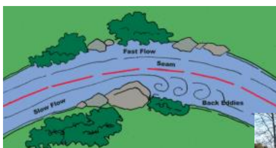
*Characterised by:*
→ Gradual slope
→ Snake-like, meandering pattern
→ Constantly self organising (trying to reach 'equilibrium')

Outer parts = max velocity, greatest erosion
Inner parts = min velocity, sediment deposition



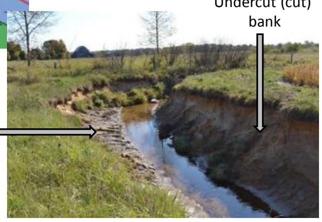
## Undercutting and Point Bar deposits

Outer parts = max velocity, greatest erosion
Inner parts = min velocity, sediment deposition



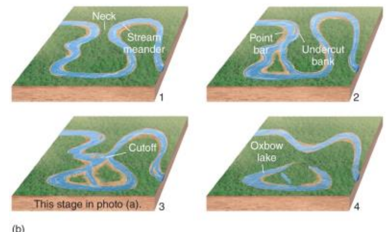

Undercut (cut) bank

Point bar deposit



Eventually scour, deposit and move the stream through time…

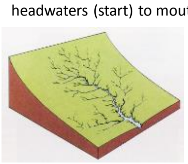
## Meandering Stream Development

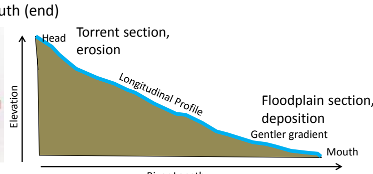



## Other Stream/River Characteristics

*Stream Gradient:*

→ Stream inclination: The decline in elevation of the stream channel from headwaters (start) to mouth (end)






*Nickpoints:*

→ Longitudinal profile has abrupt change in gradient, e.g. waterfall, rapids.
→ Conversion of potential energy (at lip) to kinetic energy (at base)
→ Work to smooth out the gradient

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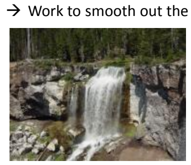
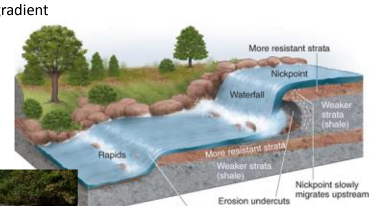
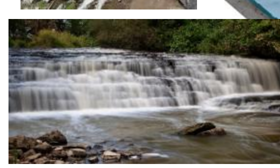




## Deposition Land Formations

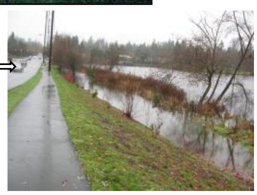
Weathering → Mass Movement → Erosion → Transportation → Deposition

*Deposition of alluvium* → Creates:

Sandbars ⇒

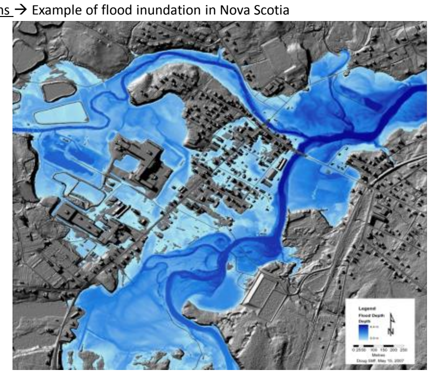
Floodplains → Flat areas on sides of stream channels
→ frequent flooding as water overtops banks
→ Sediments accumulate in thickness

→ Natural levees formed as water spreads out



## Deposition Land Formations

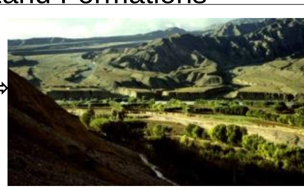
Floodplains → Example of flood inundation in Nova Scotia



## Deposition Land Formations

*Deposition of alluvium* → Creates:

Alluvial Terraces → Uplifing of the landscape, scouring down of stream
→ Appear like steps in the topography

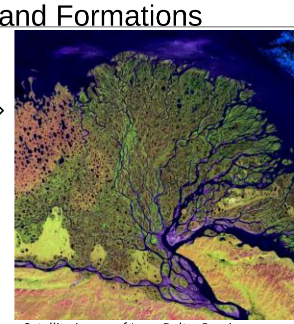


Alluvial Fans → Occurs at the mouth of a canyon
→ Often found in arid environments, ephemeral stream.
→ Formed during flash floods, movements of vast quantities of sediment

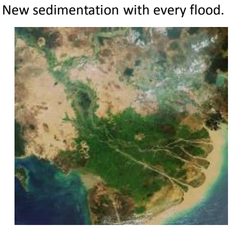
## Deposition Land Formations

*Deposition of alluvium* → Creates:

River Deltas → Occurs at the mouth of a river at base level.
→ Abrupt deceleration of water into larger water body.
→ Coarse sediments near mouth, finer sediments carried further
→ New sedimentation with every flood.



Satellite image of Lena Delta, Russia



Satellite image of Mekong Delta, Vietnam

Pre and post hurricane Katrina, New Orleans

Reading for Friday: Characteristics of ocean and coastal systems, Chapter 12. Pgs. 377 – 386.