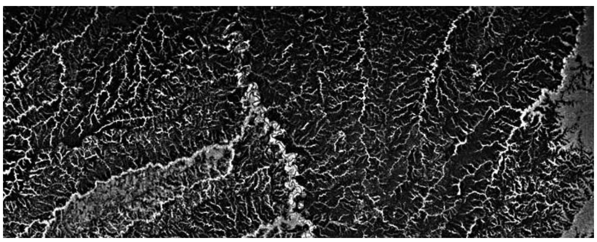
Geog 1000 - Lecture 19

Fluvial Geomorphology and River Systems

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



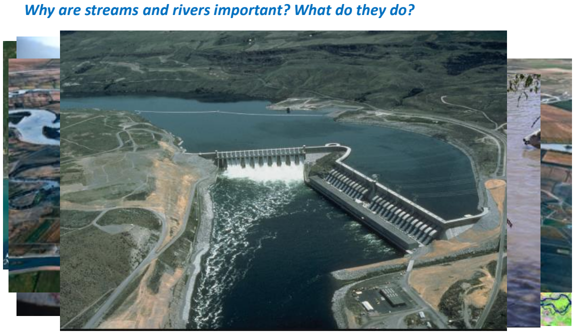
Today's Lecture (Pgs 346 – 355)

1. What is Fluvial Geomorphology?
2. Hydrology and the Water Cycle
3. Defining the Drainage Basin
4. Drainage basin processes
5. Drainage patterns
6. Stream discharge and the stream hydrograph
7. Types of rivers and their formation

Fluvial Processes

Processes related to streams and rivers.

Why are streams and rivers important? What do they do?



What is Fluvial Geomorphology?

Fluvial → Stream and river processes: WATER

Fluvial Geomorphology → Movement of sediment along with water down streams.

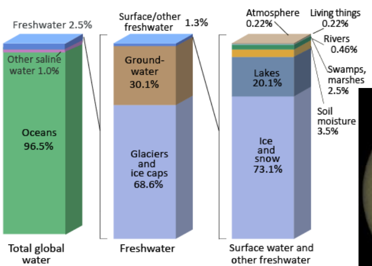
→ Fluvial geomorphology shapes the landscape

→ What changes will occur to the stream channel in response to local changes (in the *watershed*)?

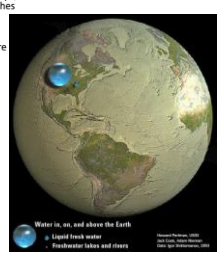
Before we get into Fluvial Geomorphology, we'll start with the Water Cycle!

Water and People: Some Interesting Statistics

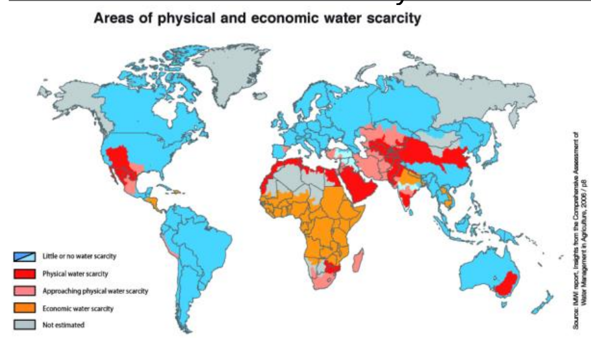
Where on Earth is our Water?



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).



Global Water Scarcity Index



Economic water scarcity → enough water, but great economic costs required to ensure proper management (so that it doesn't become physically scarce)

<u>From the United Nations</u>:

85% of population live in driest half of the planet.

783 million people → no access to clean water.

2.5 billion people → minimal sanitation.

6 to 8 million people → die per year from disasters and water-related disease.

~3.5 Earth's would be needed to sustain current population at N. Am. Lifestyles (!)

Population increase of 2-3 billion people over 40 yrs. Predicted increase in food demand = 70% greater by 2050. Energy demand predicted increase by 60% over 30 years.

Water availability to decrease, but consumption will increase by ~19% by 2050.

Agriculture accounts for ~70% of global freshwater withdrawals.

1 kg of beef requires ~ 15000 L of water, 1 cup of coffee = 140 L of water used.

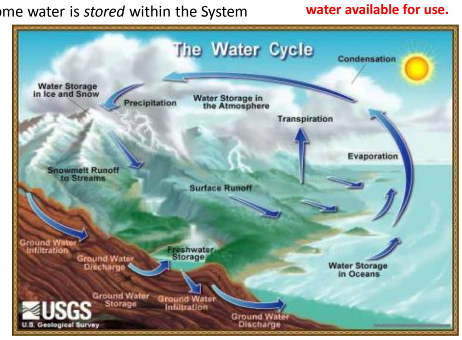
Exploring Hydrological Processes in Space and Time

Hydrology and the Water Cycle

Water goes *into* the System → Water goes *out* of the System.

→ Some water is *stored* within the System

Important because provides *actual* water available for use.



Inputs to the Water Cycle

Water flowing into the system

- Precipitation → Rain and Snow


Outputs from the Water Cycle

Water leaving the system

- Snowmelt runoff into streams → eventually to the ocean
- Below ground water movement to streams
- Surface water runoff
- Evaporation (water from soil, water bodies changing state)
- Transpiration (water from plant surfaces changing state)



Storage in the Water Cycle

Water staying in the system over long periods of time:

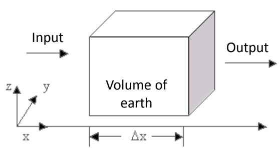
- Fresh water storage in lakes, ponds, wetlands
- Water storage in soil/aquifers (underground water in rocks)
- Water storage in ice and snow
- Water storage in oceans and atmosphere


The Water Cycle and the Control Volume

Understanding water availability requires a Control Volume:

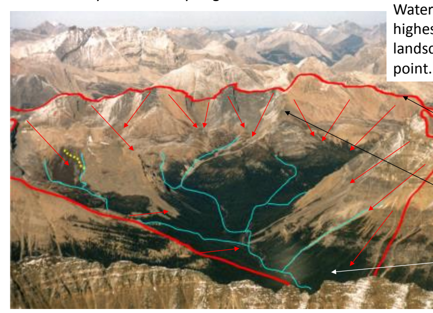
→ An volume of the land surface (with depth) that water flows into, out of, and is stored in *through time*.

Also Known as a *Watershed* *or* *Drainage Basin* *or* *Catchment*

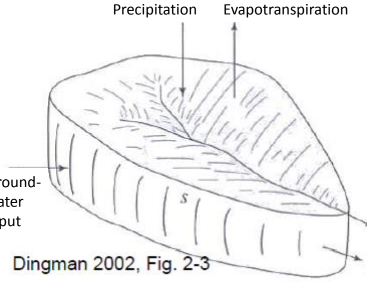


The Watershed

Surface water runs into increasingly larger streams, rivers that form a ***Watershed***
→ can be very small to very large

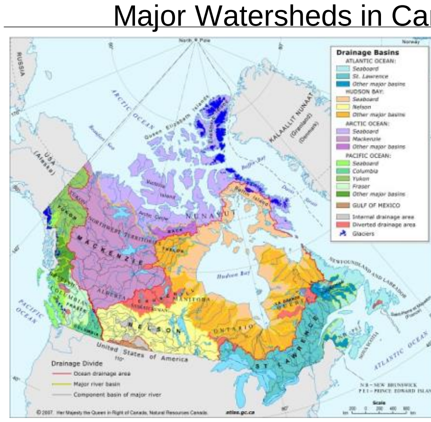


The Control Volume Watershed



Dingman 2002, Fig. 2-3

Major Watersheds in Canada



Some Drainage Basin Facts:

- ~49% of Earth's land drains into the Atlantic Ocean.
- 13+% drains to the Pacific Ocean.
- Arctic ocean drains most of Northern and Western Canada

Largest Watersheds in the World

1. Amazon

Amazon River – 2nd longest R in the world.
- Discharge ~209,000 $m^3 s^{-1}$
- Area = 7,050,000 km^2
- 1/5 of world's total river flow
- Originates in Peruvian Andes

2. Rio de la Plata

Rio de la Plata (River Plate)
- Widest river in the world, max width = 220 kms
- Area = 4,144,000 km^2
- Paraguay and Uruguay Rivers
- Carries 57,000,000 $m^3 yr^{-1}$ of silt Rio de la Plata

3. Congo

Congo River
- 3rd largest river in the world
- Drains 4,014,500 km^2
- Discharge ~41,000 $m^3 s^{-1}$
- Most powerful river in Africa → hydroelectric power.

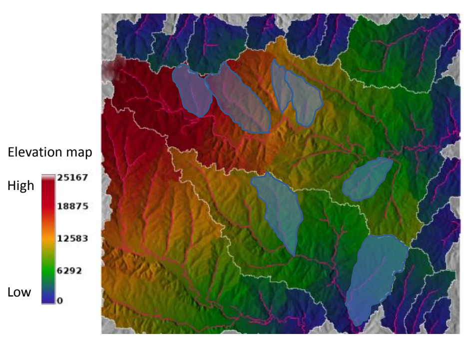
Largest Watersheds in the World

Largest watersh
1. Amazon

Oldman River: Length of 362 kilometers
- Drainage area of 26,700 km^2
- 95 $m^3 s^{-1}$

Amazon River
the world.
- Discharge
- Area = 7,05
- 1/5 of worl
- Originates i
st river in the
014,500 km^2
e ~41,000 $m^3 s^{-1}$
Rivers
- Carries 57,000,000 $m^3 yr^{-1}$ of silt Rio de la Plata
Africa → hydroelectric power.

Watersheds and Sub-Watersheds



Flow of Water through a Watershed

- **Drainage divide** → Ridges and areas of high elevation that divide watersheds
- **Surface overland flow** → Thin film of water that runs down slope after precipitation event
- **Rills** → Thin film of water runs into small grooves, depressions
- **Deeper gullies** → Small grooves, depressions deepen as more water moves through them
- **Streams** → Low *order* streams appear (smallest stream = 0, river = 5, 9, etc.)
- **Rivers** → Streams intersect to form rivers

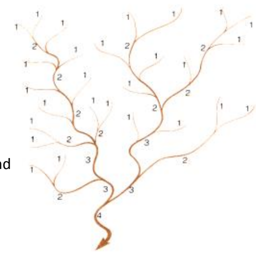
Description of Stream Networks:

Stream Networks based on Stream Order:

1st order streams → have no tributaries

2nd order streams → confluence of two first order streams

3rd order streams → confluence of two second order streams … etc.



Examining Drainage Patterns: Density

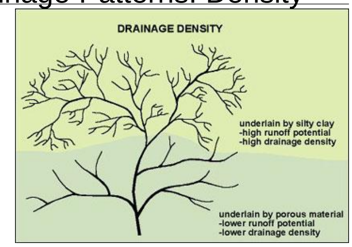
Drainage Density (D_d) (km km^{-2}):

$$D_d = \frac{\sum L}{A_D}$$

A_D → An area
ΣL → Total length of streams draining *that* area

In other words:

Total length of the streams divided by the area of the watershed.



→ Related to ave. P (low in arid and humid areas, high in wetter area).

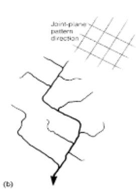
→ Also higher in less permeable soils.

Drainage Patterns

a) *Dendritic*
→ Efficient movement of water because stream lengths are fairly short, join to next branch.
→ Looks like a 'tree'


(a)

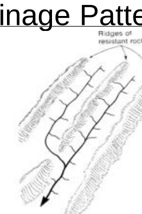
b) *Rectangular*
→ Formed by jointed/faulted rocky terrain
→ Right angle stream intersections



(b)

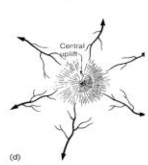
Drainage Patterns:

c) *Trellis*
→Valleys and ridges where rocks have different resistance to erosion
→ Also folded topography
→ Often at right angles to main river, moves down mountain slopes

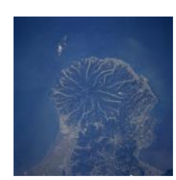


(c)

d) *Radial or Annular*
→ Created by dome structures (e.g. volcanoes), water moves down sides away from central area



(d)



Drainage Patterns:

e) Parallel
→ Water moves in parallel streams associated with steep slopes

f) *Deranged*
→ No clear pattern of drainage, no true stream valley.
→ Surface disrupts stream flow, creates ponding

Introduction to 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)

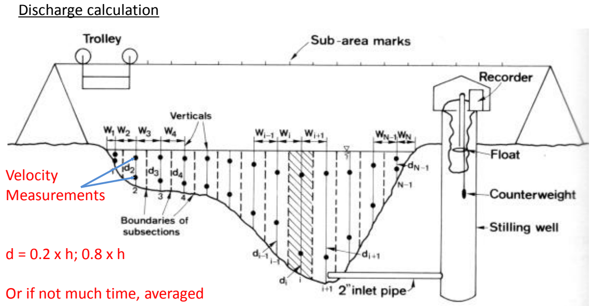
Defined as: Rate of flow of water volume (including sediments etc.)
Units = volume length of travel per unit time (e.g. $m^3\ s^{-1}$).

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

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

Determining discharge from transects:

Discharge calculation



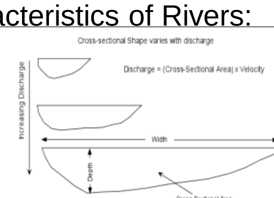
Velocity Measurements

d = 0.2 x h; 0.8 x h

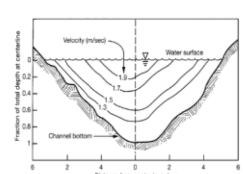
Or if not much time, averaged at d = 0.6 x h

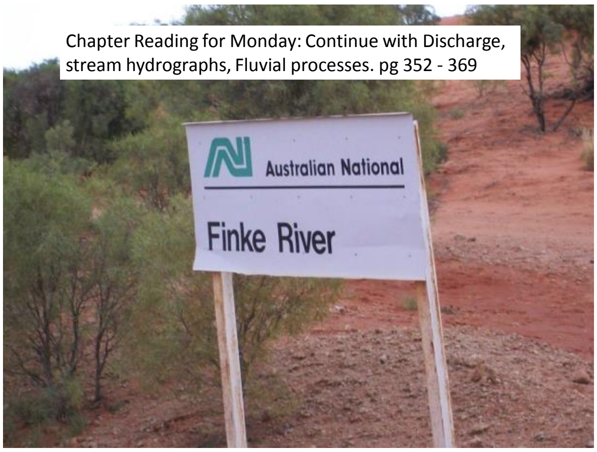
Discharge Characteristics of Rivers:

Discharge increases as stream cross sectional area increases



Discharge is greatest in the middle of the stream where there isn't much friction




Chapter Reading for Monday: Continue with Discharge, stream hydrographs, Fluvial processes. pg 352 - 369
Australian National
Finke River