ESRM 304

Environmental and Resource Assessment

Soils and Microclimate

Daniel Vogt
&
Korena Mafune

Soils and Micro-climate Module

What will we do???

- **Monday** – Micro-climate & soils methods for field trip
- **Wednesday** – Soil surveys & N assessment
- **Friday** – St Edward soils and N calculations

Objectives/Goals

- Describe/characterize some Micro-climate & Soil parameters
- Assess micro-climate and soils at 4 sites
  - ✓ Quantitatively - using basic methods
  - ✓ Qualitatively – visually
- Compare soils at 4 sites to the soil map
- Link micro-climate/soils to other modules

Characterizing the Physical Environment

Focus is LOCAL, not regional or global

What are the site properties?

What site properties might *constrain* management activities?

Are there sensitive areas that *might be affected* by management?

Reading: Anderson and Ingram, Tropical Soil Biology and Fertility: A Handbook of Methods, Chap. 2: Site Description available as electronic reserve on the web page

Also at the library: Brady and Weil, Elements of the Nature and Properties of Soils

We'll focus on 2 aspects of the Physical Environment:

Microclimate

Soils

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Microclimate

= ***Local climatic conditions that differ from the regional climate***

This difference can be caused by, eg
topography, vegetation, humans…

For example,

- **Air temperature**
- **Soil temperature**
- **Precipitation: Quantity & Chemistry of:**
  - **Rainfall,**
  - **Snowfall**
- **Wind**
- **Solar radiation**

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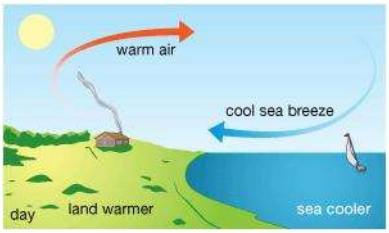
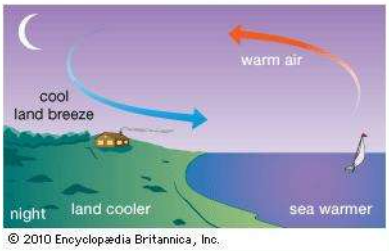
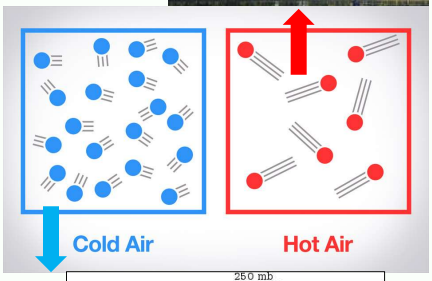
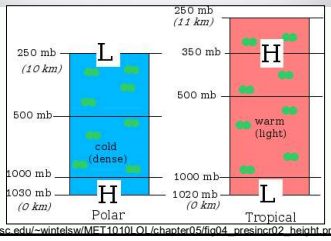
A few basic atmospheric principles:

Cold air *sinks*: more dense
Hot air *rises*: less dense









http://apollo.lsc.vsc.edu/~wintelsw/MET1010LOL/chapter05/fig04_presincr02_height.png

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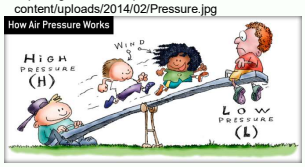
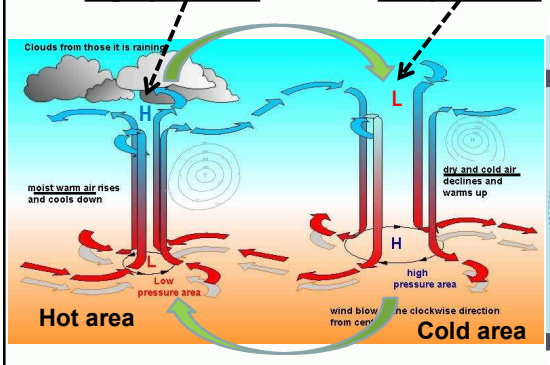
A few basic atmospheric principles:

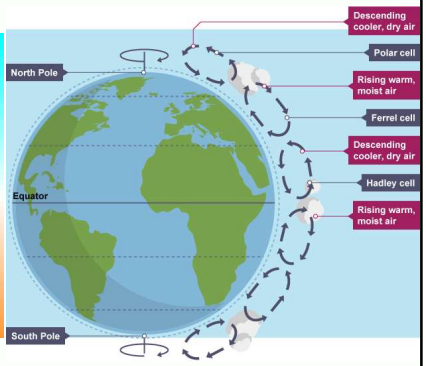
Cold air sinks: more dense
Hot air rises: less dense

Air moves from
high pressure areas to low pressure areas.

http://dogfoose.com/wp-content/uploads/2014/02/Pressure.jpg







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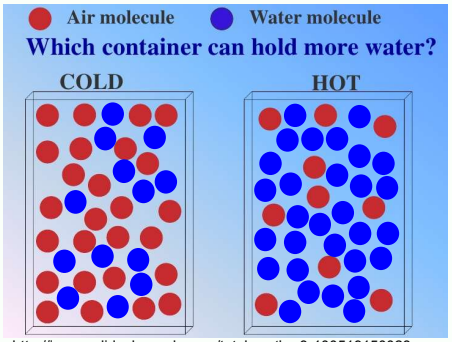
A few basic atmospheric principles:

Cold air sinks: ***more dense***
Hot air rises: ***less dense***

Air moves from high pressure areas ⟶ low pressure areas

Hot air holds more water



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A few basic atmospheric principles:

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AND EVEN

Changing vegetation can affect:

- **soil and air temperatures,**
- **wind patterns,**
- **humidity,**
- **light, etc…..**

which can affect revegetation, restoration...

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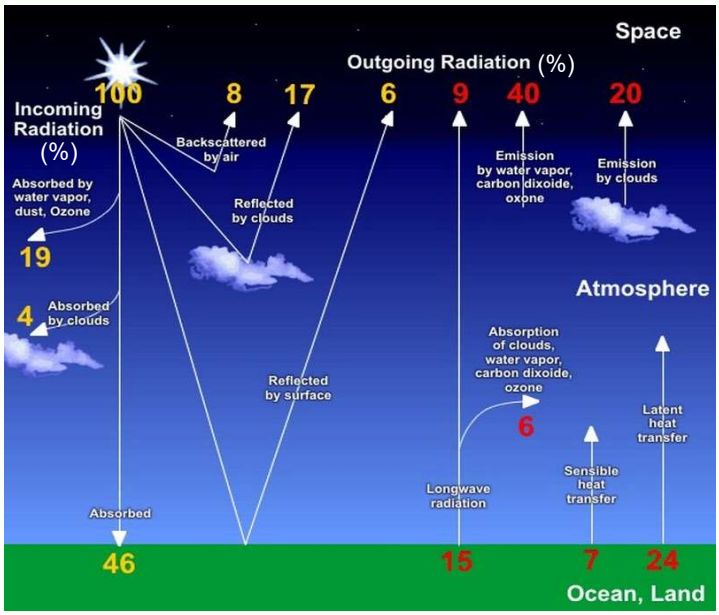
Energy Balance



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Vegetation effects on micro-climate

Changes in **air temperature** from forested to open areas (*with little topographic effect in this case)*

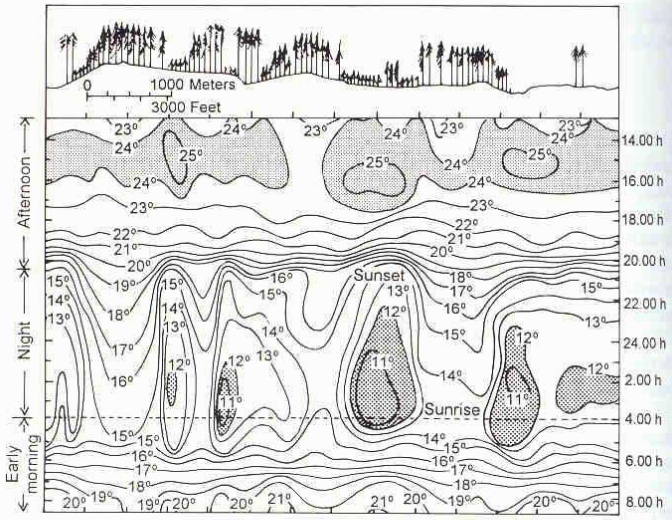

Fig. 10.6. Comparing summer temperature changes in wooded patches and clearings over 20 hours. Along a 7 km line (diagram at top) chest-height temperature measurements were made (in °C) every hour (reading downward). Upper shaded areas = highest afternoon temperatures; lower shaded areas = lowest night temperatures. Maximum topographic relief = 20 m. Adapted from Geiger (1965). Originally published in the German language by Friedr. Vieweg & Sohn Braunschweig 1961.

Forman 1995

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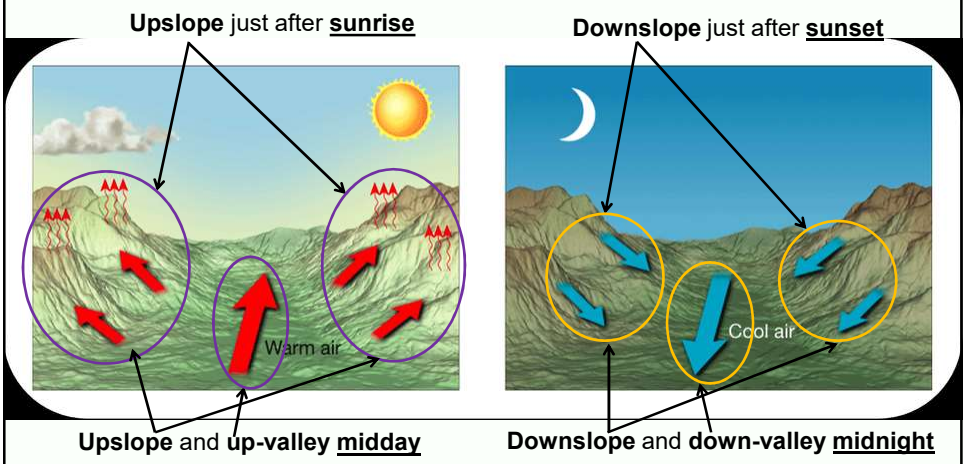
Example of Topographic effects on winds



https://kaiserscience.wordpress.com/earth-science/weather/regional-wind-systems/

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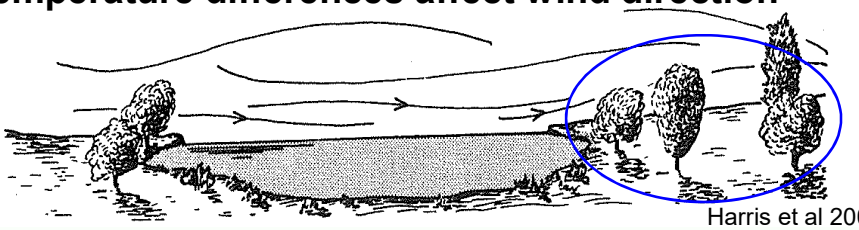
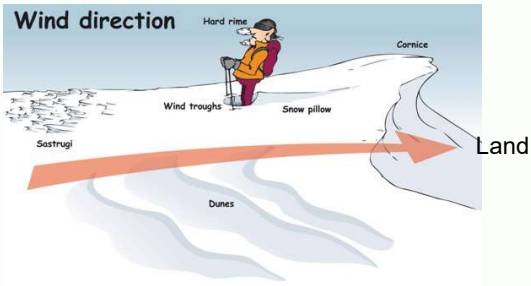
Temperature differences affect wind direction



Harris et al 2004

- Water - A large body of water can moderate air temperature, particularly on the leeward side (downwind) of the water

- Glaciers - glaciers are cooler than adjacent exposed land creating wind currents to the land.



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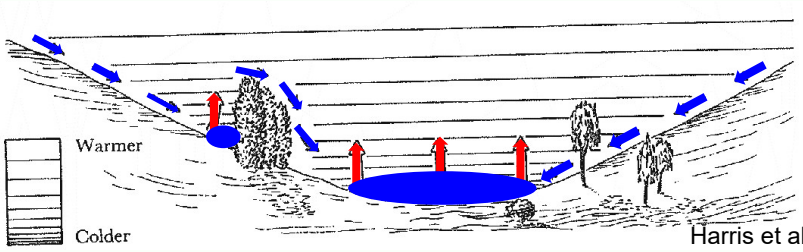

Harris et al 2004

- A **frost pocket** can form when cold air (heavier) *flows* down slopes and *forces* warmer air to rise.
- **Obstructions** on slope can also form localized cold pockets

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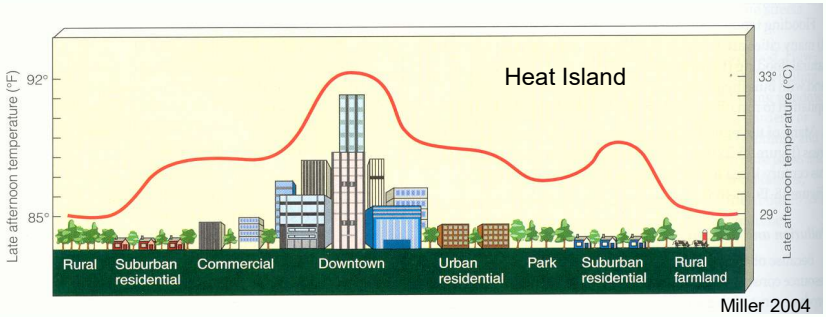
Human effects on micro-climate
Urban climate



Miller 2004

Example of an idealized **urban heat island** showing late afternoon temperature changes with density of development.

Wind???

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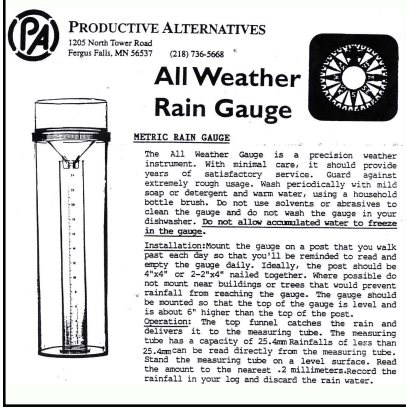
Microclimate measurements

Temperature
Wind speed
Rainfall (quantity and quality)
Throughfall (quantity and quality)



PRODUCTIVE ALTERNATIVES
1205 North Tower Road
Fergus Falls, MN 56537 (218) 736-5668

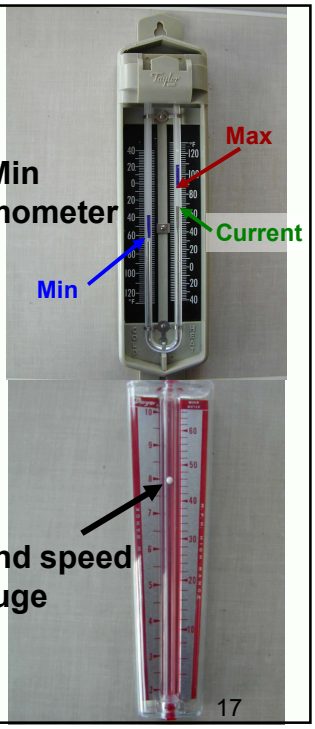
All Weather Rain Gauge

METRIC RAIN GAUGE

The All Weather Gauge is a precision weather instrument. With minimal care, it should provide years of satisfactory service. Guard against extremely rough usage. Wash periodically with mild soap or detergent and warm water, using a household bottle brush. Do not use solvents or abrasives to clean the gauge and do not wash the gauge in your dishwasher. Do not allow accumulated water to freeze in the gauge.

Installation: Mount the gauge on a post that you walk past each day so that you'll be reminded to read and empty the gauge daily. Ideally, the post should be 4"x4" or 2-2"x4" nailed together. Where possible do not mount near buildings or trees that would prevent rainfall from reaching the gauge. The gauge should be mounted so that the top of the gauge is level and is about 6" higher than the top of the post.

Operation: The top funnel catches the rain and delivers it to the measuring tube. The measuring tube has a capacity of 25.4mm Rainfalls of less than 25.4mm can be read directly from the measuring tube. Stand the measuring tube on a level surface. Read the amount to the nearest .2 millimeters. Record the rainfall in your log and discard the rain water.



Max/Min Thermometer

Wind speed gauge

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Micro-climate can *affect*:

vegetation
wildlife
soils
water ….

By changing temperature, water, wind….

Vegetation, wildlife, soils, water… can affect micro-climate!!

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Soils

Know what's there:

- **soil types**
- **landscape patterns**
- **major physical properties**
- **chemistry?**
- **biota?**

➢ **Past land-use effects**

Indianola soil

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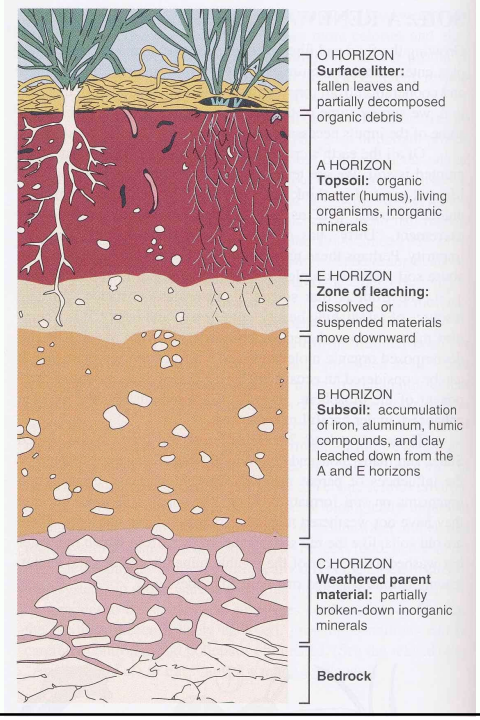

An example of a cross section of a soil showing a <u>soil</u> <u>profile</u> that includes possible soil horizons.

Actual soil profiles will vary in the number and type of horizons that are present, and in the sequence of horizons.

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ALDERWOOD SOIL SERIES

The Alderwood series consists of moderately deep to a cemented pan, moderately well drained soils formed in glacial till. Alderwood soils are on glacially modified foothills and valleys and have slopes of 0 to 65 percent. The average annual precipitation is about 40 inches, and the mean annual temperature is about 50 degrees F.

TYPICAL PEDON:
Ap--0 to 7 inches; very dark grayish brown; gravelly ashy sandy loam; moderate fine granular structure; slightly acid (pH 6.2). (3 to 7 inches thick)

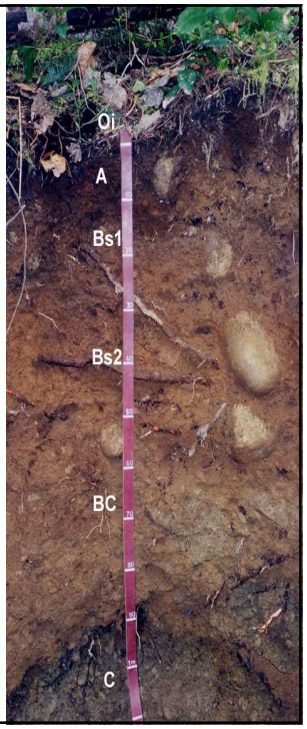
Bs1--7 to 21 inches; dark yellowish brown; very gravelly ashy sandy loam; weak medium subangular blocky structure; slightly acid (pH 6.2).

Bs2--21 to 30 inches; dark brown; very gravelly ashy sandy loam; weak medium subangular blocky structure; slightly acid (pH 6.2). (Combined Bs1 and Bs2 horizons are 15 to 30 inches thick)

2Bs3--30 to 35 inches; 50% olive/yellowish brown and 50% dark greyish brown; very gravelly sandy loam, some cemented fragments, massive; moderately acid (pH 6.0). (0 to 15 inches thick)

2Bsm--35 to 43 inches; dark grayish brown cemented layer that crushes to very gravelly sandy loam; massive; 40 percent pebbles; moderately acid (pH 6.0). (5 to 20 inches thick)

2Cd--43 to 60 inches; grayish brown compact glacial till that breaks to very gravelly sandy loam; massive; extremely hard; 40 percent pebbles; moderately acid (pH 6.0).



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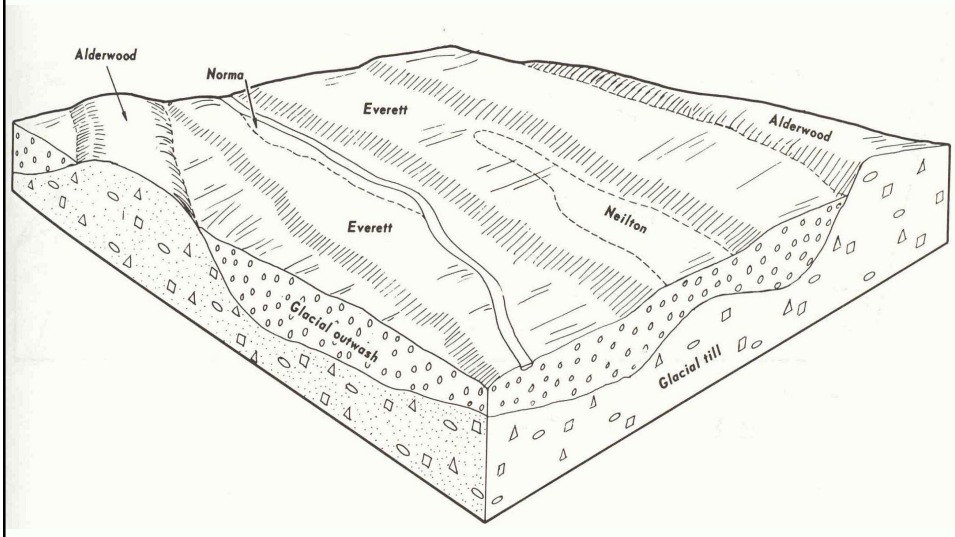
Soil types and Landscape Patterns



A soil association common in the Puget Sound area showing soil type relative to different glacial deposits

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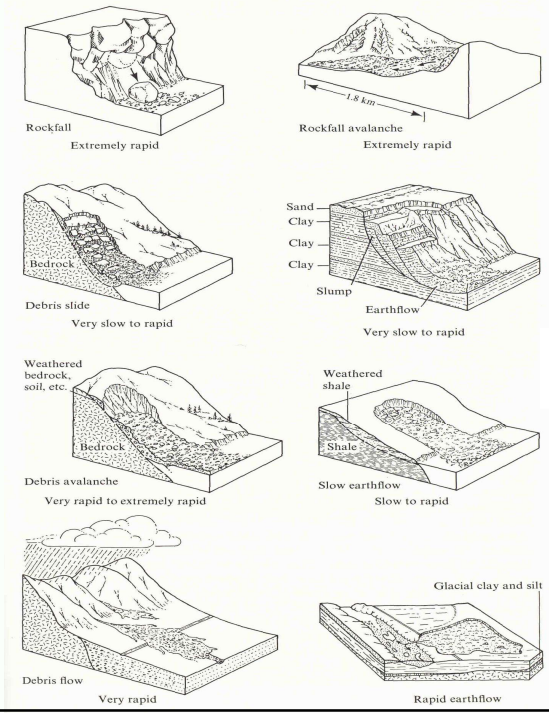
Land and soil stability

Examples **of types of** **hillslope failures**

Soil type **is typically related to** **slope stability**



Dunne and Leopold, 1998

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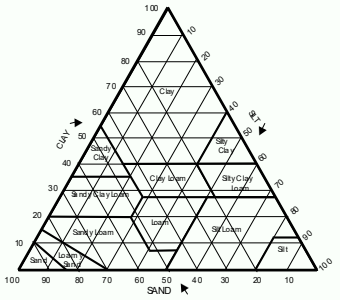
Physical properties of importance

aggregation
texture (sand, silt and clay)
rock and gravel content
abrupt textural changes
infiltration rate
bulk density
- BD = mass dry soil/ volume
- Typical range is 0.8 to 1.2 g cm^{-3}

hydrophobicity
moisture regime
temperature regime
color
- (OM, Fe, wetness)

soil depth



Chemical properties of importance

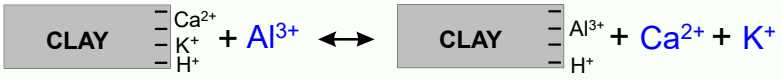
pH (measure of acidity and alkalinity—forest soils naturally acidic)

Organic matter content (Is an O horizon present?
- Is there an A horizon? OM content varies by soil type and decreases with depth in mineral soil). What affects OM accumulation? Decomposition is faster when oxygen is present.

Nitrogen (in young soils, often the most limiting nutrient)

Total and available nutrient content

Cation Exchange Capacity (available nutrient storage capacity of a soil)



clays, OM and oxides provide CEC

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Cation Exchange Capacity (available nutrient storage capacity of a soil)
clays, OM and oxides provide CEC

Base Saturation % of storage sites filled with certain nutrients
(Ca, Mg, K, Na)

Trace metal content

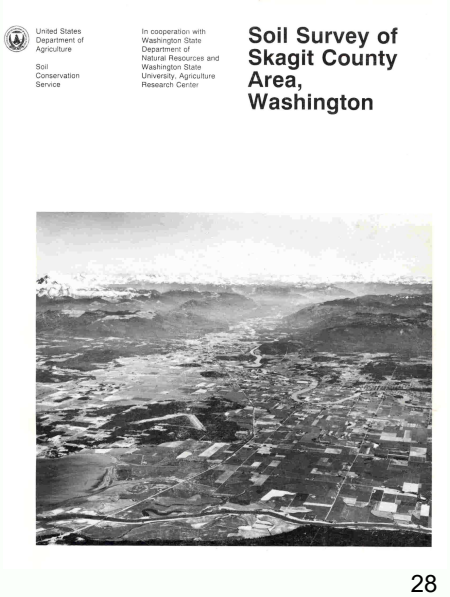
Carbonates

Oxidizing/Reducing conditions

Collecting Soil Information

Soil Surveys

Maps
Profile descriptions
Tables on soil properties:
physical,
chemical
engineering
land capabilities
plant growth



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Soil Measurements in the Field

Soil horizons depths and properties

Soil temperature

Depth to water table

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Collect 'grab' samples for chemical analysis
Known volume sample for bulk density

With horizon depth, bulk density and concentration, you can then determine the quantity of an element in an area

One way to measure bulk density is using a corer

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Sieve samples to 2mm

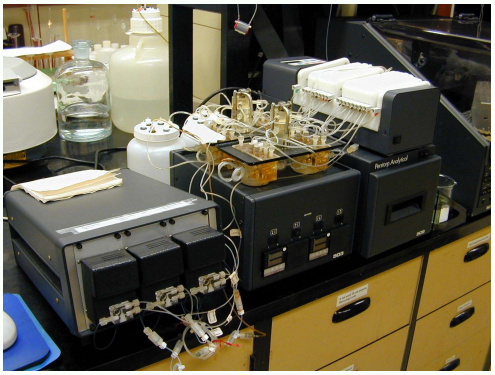
Air dry samples after returning from field for chemical analysis

Oven dry for moisture content or bulk density (105°C)

2mm sieve

Balance 31

Some Soil analyses….



Total N using combustion (CHN)

Flow analyzer for (NH_4, NO_3, SO_4,…)

pH meter

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Understand the need/uses for information (know what you need and why

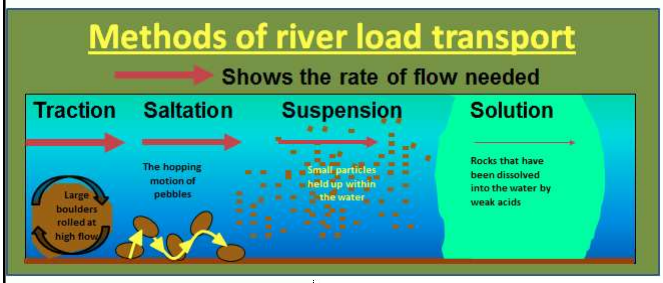
Gather available knowledge of the site

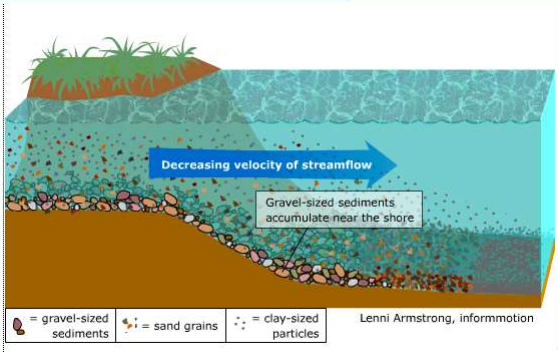
Develop a plan for collecting data

Understand the limitation of data

Make sure the data collection will address needs without bias or waste

Sorting of soil particles by density





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