

Water

distribution of Earth's Water

- 1) 97% of water in ocean.
- 2) Icecaps and glaciers - 2%.
- 3) <1% in lakes, streams, groundwater and the atmosphere.

hydrologic cycle - earth's water balance

an unending cycle of Earth's water supply.

- 1) Gigantic system powered by Sun's energy.
- 2) Atmosphere provides vital link between oceans and continents. Water from Oceans, and to lesser extent Continents, is constantly evaporating back to atmosphere.
- 3) Moisture laden air is then moved by winds and develops into cloud fronts where it rains back down.
- 4) Moisture that rains on Continents makes its way back to Oceans.

On the earth's surface can have:

- a) infiltration - water soaks into the ground; or
- b) run-off - water flows on the ground surface; or
- c) evapotranspiration - release of water which is taken up by plants and released to the atmosphere.

Since total amount of water vapor in atmosphere remains the same:

$$\text{average annual precipitation} = \text{quantity of water evaporated}$$

For the continents: Precipitation > Evaporation

For the Oceans: Evaporation > Precipitation

Since the levels of the world oceans are not dropping, runoff from land areas must balance the deficit of precipitation.

Running Water

Running water is a minor component of the water budget;
still an enormous amount capable of wearing down Earth's surface.

Stream - channeled flow of any kind;

River - main channel to which tributaries drain.

Streams are supplied by runoff and recharged by ground water.

Streamflow

Stream's velocity is primary factor controlling flow type:

Flow in a stream channel is primarily:

1) turbulent flow - a complex type of movement that shows a confused pattern of streamlines crossing, mixing, interfering, etc. e.g. whirlpool like eddies associated with fast-moving rivers.

It erodes streams channel and keeps sediment suspended so it can be moved downstream.

The velocity of a stream is measured in terms of the distance the water travels in a given unit of time. Vary from 1-30 km/hr.

In a straight channel, highest velocities are in the center of the stream just below the surface where there is the least friction.

Minimum velocities occur along sides and bottom (bed) of the channel where friction is greatest.

In curved channel, zone of maximum velocity is on outside of bend.

The ability of a stream to erode and transport material is directly related to its velocity.

Factors controlling the velocity of a stream include:

1) Gradient - or slope of the channel.

the vertical drop of stream over fixed distance.

Higher gradient, more energy available for stream flow.

2) Cross-sectional shape of channel - determines the amount of water in contact with channel and determines frictional drag.

The most efficient channel - one with the least perimeter for its cross-sectional area.

3) Discharge - the amount of water flowing past a certain point in a given unit of time.

Measured in m^3/sec or ft^3/sec .

A function of stream's cross sectional area times velocity.

Amazon has greatest discharge - accounts for ~15% of all fresh water discharged into the oceans.

As the amount of water in a stream increases, the width, depth, and velocity all increase in an orderly fashion.

Changes Downstream

Longitudinal profile - useful way to study a stream.

A cross-sectional view of a stream from its source area (**headwaters**) to its **mouth** (point downstream where river empties into another body of water).

- 1) A constantly decreasing gradient from head to mouth.
- 2) Discharge increases toward the mouth due to increase in number of tributaries feeding river, resulting in increased width, depth, and velocity downstream.

Base level and Graded Streams

Base level - the downward limit of stream erosion.

The lowest level to which a stream can erode its channel.

Level at which mouth of stream enters ocean, lake, or another stream.

Sea level - ultimate base level.

Local or temporal base levels include lakes, resistant layers, etc.

Stream Erosion

Streams can erode their channels in several ways:

1) by lifting loosely consolidated particles

Turbulent flow - can dislodge particles from the channel and put them into the moving water.

In this manner, moving water swiftly erodes poorly consolidated materials on the beds and banks of streams.

2) by abrasion

Solid particles carried by streams are capable of abraiding a bedrock channel. This is the way steep sided gorges are cut. Also cut **potholes** (rounded depressions) created by the abrasive action of particles swirling in fast moving eddies,

3) by solution activity.

Transport of Sediment by Streams

Streams transport their load in three ways:

1) in solution (dissolved load)

Solution is primarily the work of ground water and dissolved material in the ground water may be recharged to streams.

Expressed as ppm; average ~120 ppm.

2) in suspension (suspended load)

Most streams carry their load in suspension.

Consists of fine-sand, silt-, and clay-sized particles.

Increases during a flood.

Type and amount of material carried in suspension controlled by velocity of water.

3) along the bottom of the channel (bed load).

A portion of a stream's load of solid material that is too large is carried in suspension.

These coarser particles move along bottom of stream - bed load.

It has a major role in downcutting the channel.

Bed load moves by rolling, sliding and saltation.

Sediments moving by **saltation** bounce along stream bed.

Particles that are too heavy roll or slide along the bottom.

Bed load, in contrast to suspended load, is in motion only when the force of water is sufficient to move large particles.

For example, during flooding periods.

It usually amounts to 10% of total sediment stream is moving.

The greatest erosion and transportation of sediments occurs during floods as increase in discharge results in greater capacity.

When a stream's velocity subsides, its competence is reduced, and sediments are deposited according to size.

Generate **alluvium** - stream-deposited sediment.

Channel Deposits

Most often composed of sand and gravel - termed **bars**. Temporary features will at some point be transported downstream. Common with meandering streams where the velocity of the water on the outside increases and erodes, where the inside decreases and deposits - **point bars**. Develop fining upward sequences.

Braided Stream

Has interwoven channels which are **result of excess sediment** choking channel, forcing stream to split into several paths.

Occur when load is too great for competency or capacity of stream. Form where there is abrupt decrease in gradient or discharge.

Floodplain deposits

Floodplain is that part of valley inundated during a flood.

Rivers that occupy valleys with broad, flat floors sometimes create a **natural levee** that parallels the stream channel.

Built by successive floods over a period of several years.

As stream overflows its banks, water moves out as a broad sheet, reducing velocity and turbulence.

The coarser portion of the suspended load falls out immediately, while the finer material is laid out over the entire valley floor.

This uneven distribution produces gentle slope termed natural levee.

e.g. Natural levees of the Mississippi are 6m above the valley floor. Areas become "dammed" behind natural levee and develop marshes called **back swamps and Yazoo tributaries** (as streams are blocked from entering main channel by levee).

Deltas and Alluvial Fans

Both deposited by abrupt loss of competence in a stream.

Alluvial fans deposited on land; delta is deposited in a body of water.

Alluvial fans can be steep, while deltas are flat.

Alluvial fans - develop where high gradient stream leaves narrow valley in mountainous terrain and comes out onto a broad, flat plain.

Form in response to abrupt drop in gradient combined with the change from a narrow to a broad valley.

Delta forms when stream enters an ocean or lake.

As streams forward motion is checked entering body of water, the dying current deposits its load of sediments.

Finer silts and clays settle out greatest distance from mouth. Coarser particles deposited immediately upon entering lake.

As delta builds outward, stream's gradient constantly lessens, choking channel. Channel divides into smaller ones - **distributaries**. These distributaries carry water away from the main channel.

Stream Valleys

Valleys are the most common landform on the earth's surface.

There are 2 types of stream valleys:

- 1) Narrow V-shaped valleys; and
- 2) Wide valleys with flat floors.

Once stream has cut its channel closer to base level, downward erosion becomes less prominent.

Now more of streams energy is directed side to side.

Valley is widened, and flat valley floor and floodplain is produced.

Streams move in sweeping bends called **meanders**.

Outside of the meander is an area of erosion - called **cut bank**. Gradually, the meander is **cutoff**, and the abandoned bend is called an **oxbow lake**. Oxbow lake fills with sediment.