The poetry of the earth is never dead.
- John Keats

AP ENVIRONMENTAL SCIENCE

UNIT 1: EARTH'S SYSTEMS AND RESOURCES

TOPICS INCLUDE:
- Earth Science
- Atmosphere
- Soil

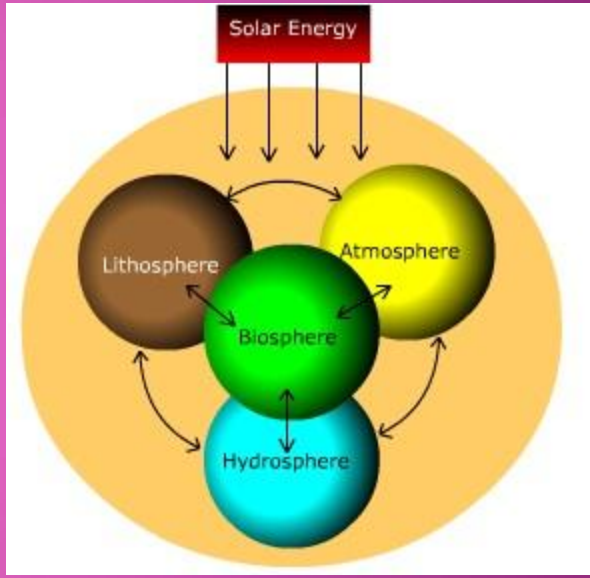
I. EARTH SYSTEMS AND RESOURCES (10-15%)

A. **Earth Science Concepts** – geologic time scale, plate tectonics, earthquakes, volcanism, seasons, solar intensity, and latitude

B. **The Atmosphere** – composition, structure, weather, climate, atmospheric circulation and the Coriolis effect, atmosphere-ocean interactions, and ENSO

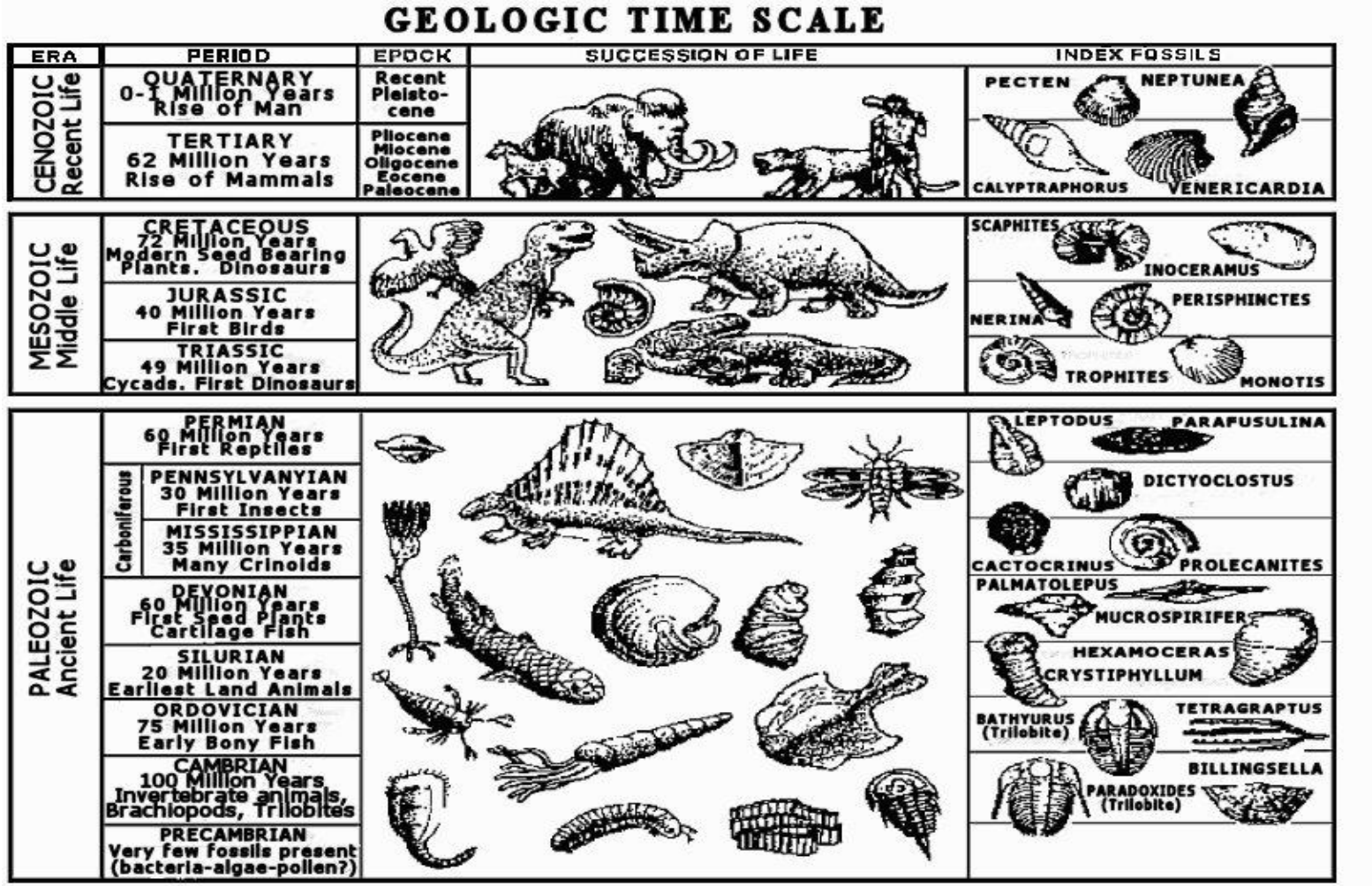
C. **Global Water Resources and Use** – freshwater, saltwater, ocean circulation, agriculture, industrial and domestic use, surface and groundwater issues, global problems, and conservation

D. **Soil and Soil Dynamics** – rock cycle, formation, composition, physical and chemical properties, main soil types, erosion and other soil problems, and soil conservation

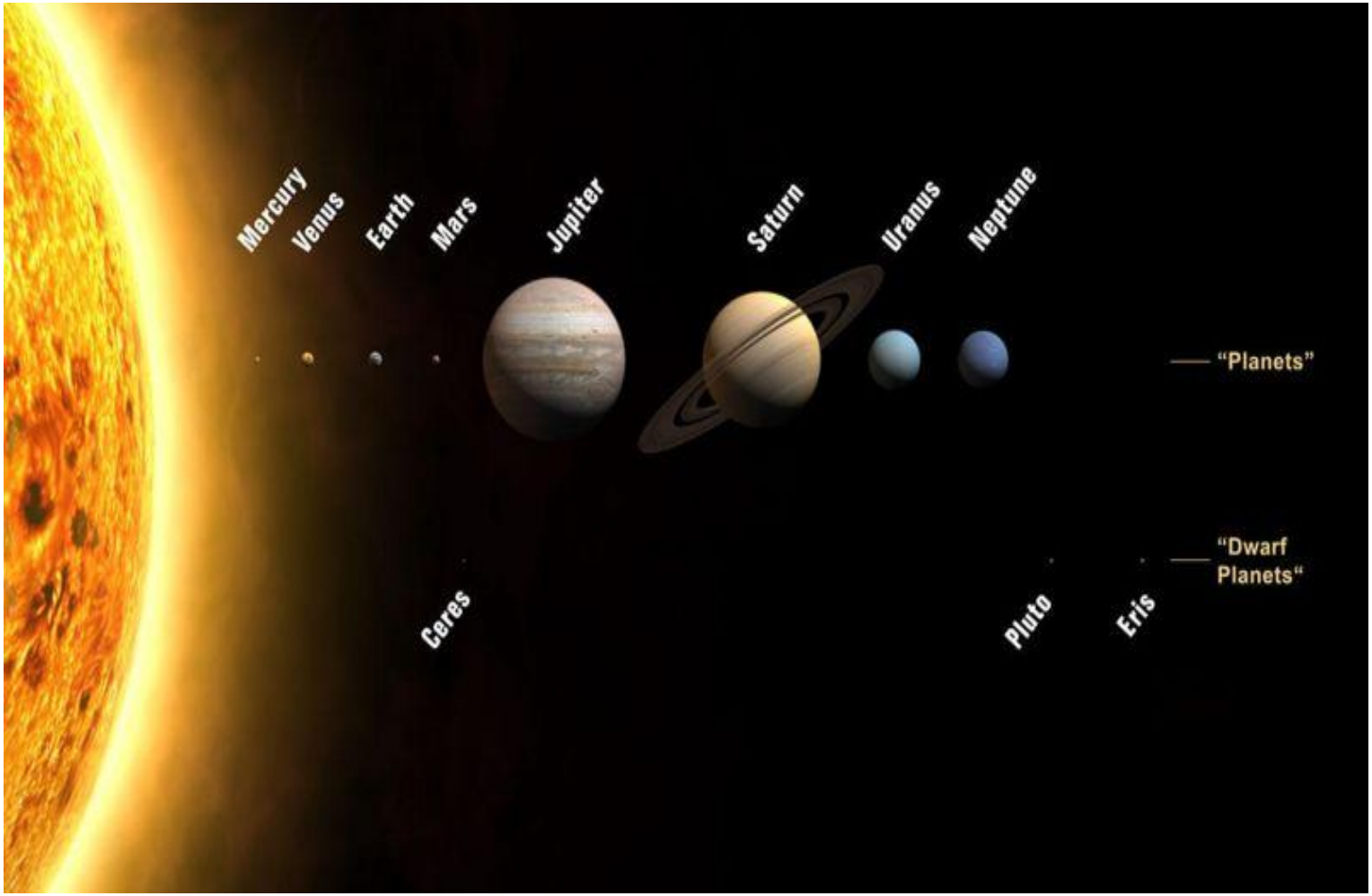


PLANET EARTH

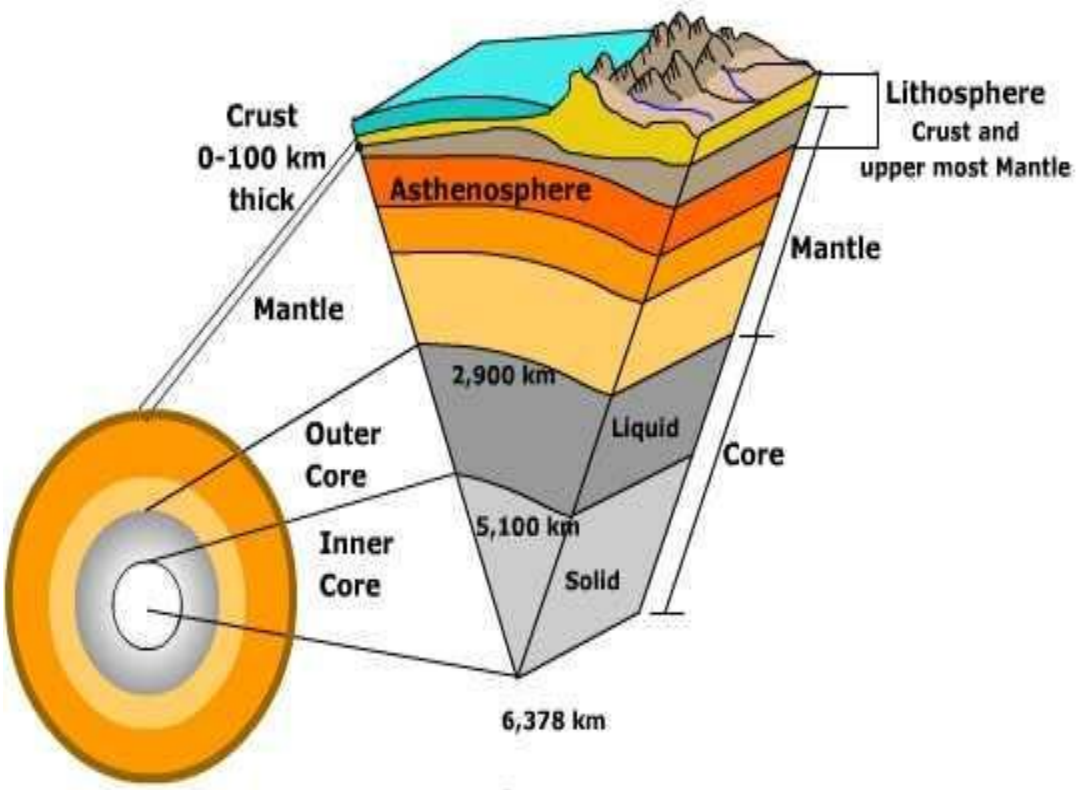
- 4.5 – 4.8 billion years old



THE SOLAR SYSTEM - EARTH



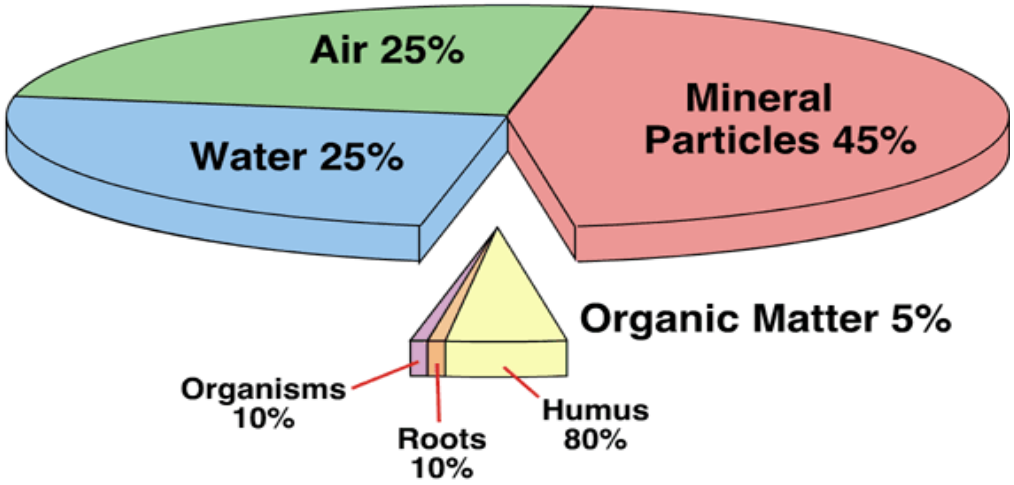
EARTH'S COMPOSITION



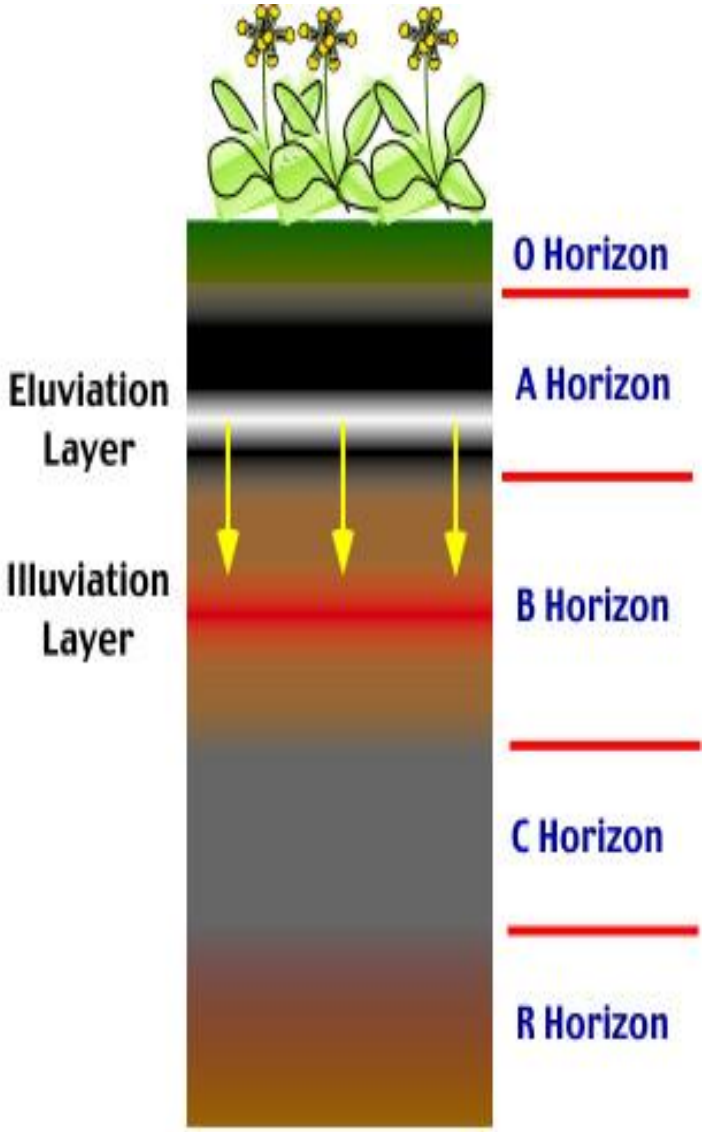
Earth Structure
(Not to Scale)

SOIL

- thin layer on top of Earth's land surface
- natural resource affects ecosystems
  - → holds nutrients & water for organisms
  - → filters and cleans water as it flows through
  - → affect the chemistry of water



SOIL PROFILE



O HORIZON (surface litter)

- leaves & partially decomposed organic debris
- Thick in deciduous forest very think in desert & tundra

A HORIZON (topsoil)

- Organic matter (humus), living organisms, inorganic minerals
- thick in grasslands

E HORIZON (zone of leaching)

- Dissolved and suspended materials move downward

B HORIZON (subsoil)

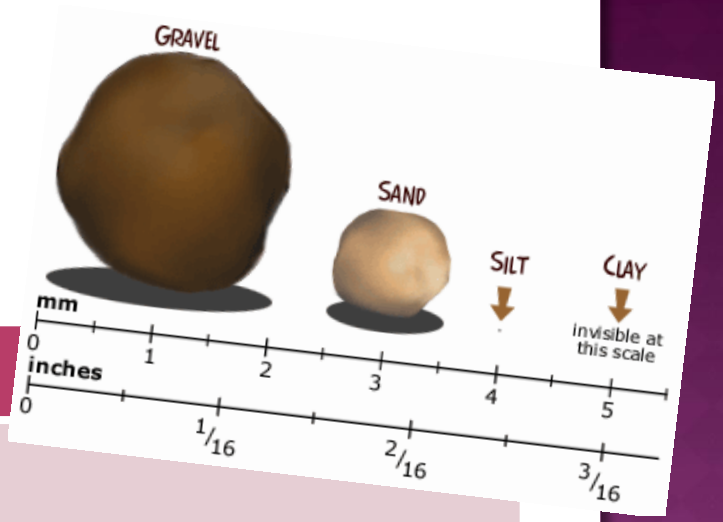
- yellowish in color b/c of iron, aluminum, humic compounds and clay that leached down
- rich in nutrients in areas where rainwater leeched nutrients from topsoil

C HORIZON (weathered parent material)

- Partially broken-down inorganic materials

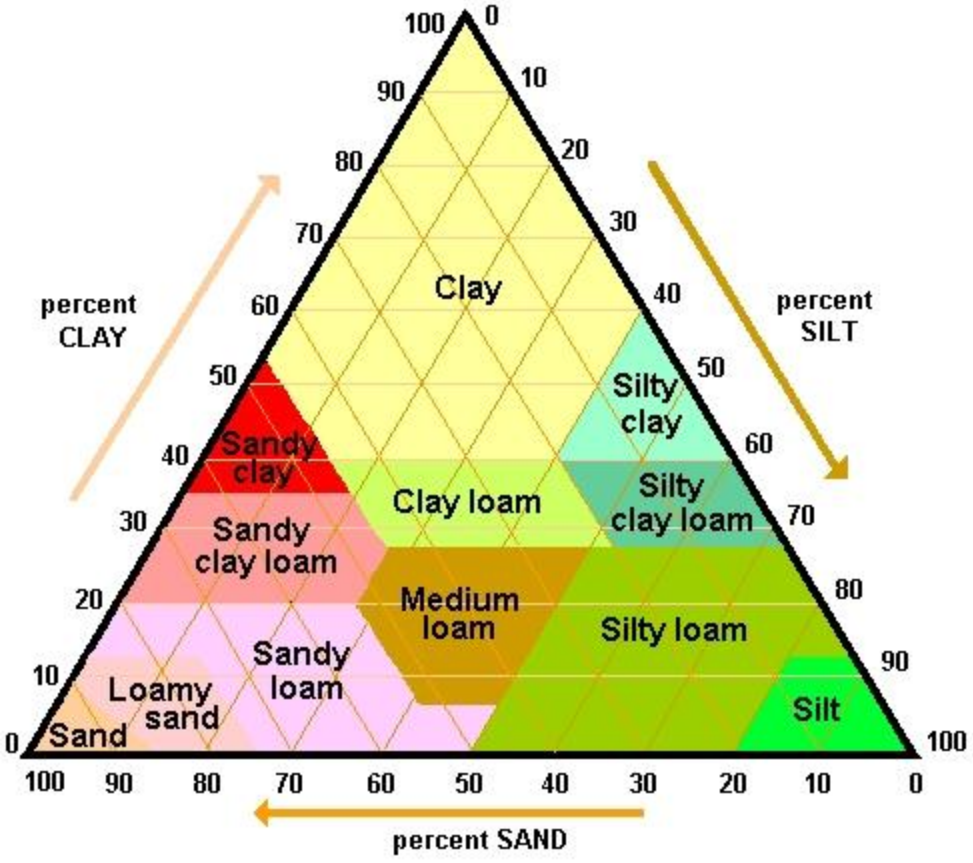
R HORIZON (bedrock)

SOIL COMPONENTS



COMPONENT	DESCRIPTION
Clay	• very fine particles • compacts easily • low permeability to water • upper layers become waterlogged
Gravel	• coarse particles • rock fragments
Loam	• equal mixture of clay, sand, silt, and humus • rich in nutrients • holds water but doesn't become waterlogged
Sand	• coarser than silt • good for crops/plants requiring low amount of water (water flows quickly)
Silt	• very fine particles (b/w size of sand & clay) • easily transported by water

A **soil texture triangle** is used to classify the texture class of a soil. The sides of the soil texture triangle are scaled for the percentages of sand, silt, and clay. Clay percentages are read from left to right across the triangle. Silt is read from the upper right to lower left. Sand from lower right towards the upper left portion of the triangle.



SOIL ANALYSIS LAB
CHEMICAL PROPERTIES

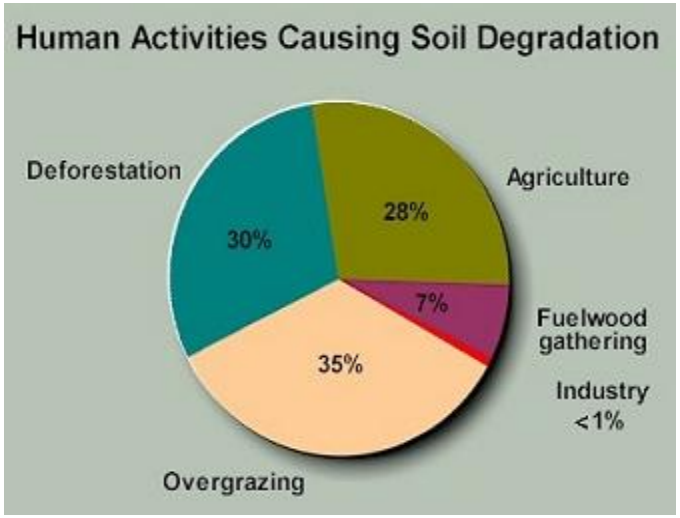
- pH: clay soil requires more lime or alum to lessen the acidity; iron (needed for plant growth) is unavailable when soil becomes alkaline; gymnosperms (pine, fir) grow better in mildly acidic soil
- nitrogen (N): plant fertilizer component
- phosphorus (P): plant fertilizer component
- potash (K): common name for compound that contains potassium oxides

SOIL ANALYSIS LAB
PHYSICAL PROPERTIES

- soil type: sand, silt or clay
- water-holding capacity: pores(spacing) b/w particles; clay has greatest capacity
- permeability: movement of gas or liquid through the soil
- friability: good soil is rich, light & easily worked w/ fingers; good for root growth
- % humus: measure of soluble organic constituents; the higher the # the better
- buffering capacity:ability to neutralize acidic compounds

SOIL DEGRADATION

- **EROSION:** soil and humus particles are picked up and carried away by wind or water



EXAMPLES OF WATER EROSION

splash erosion: raindrops hit soil & remove it

sheet erosion: small layer of soil is removed from entire area

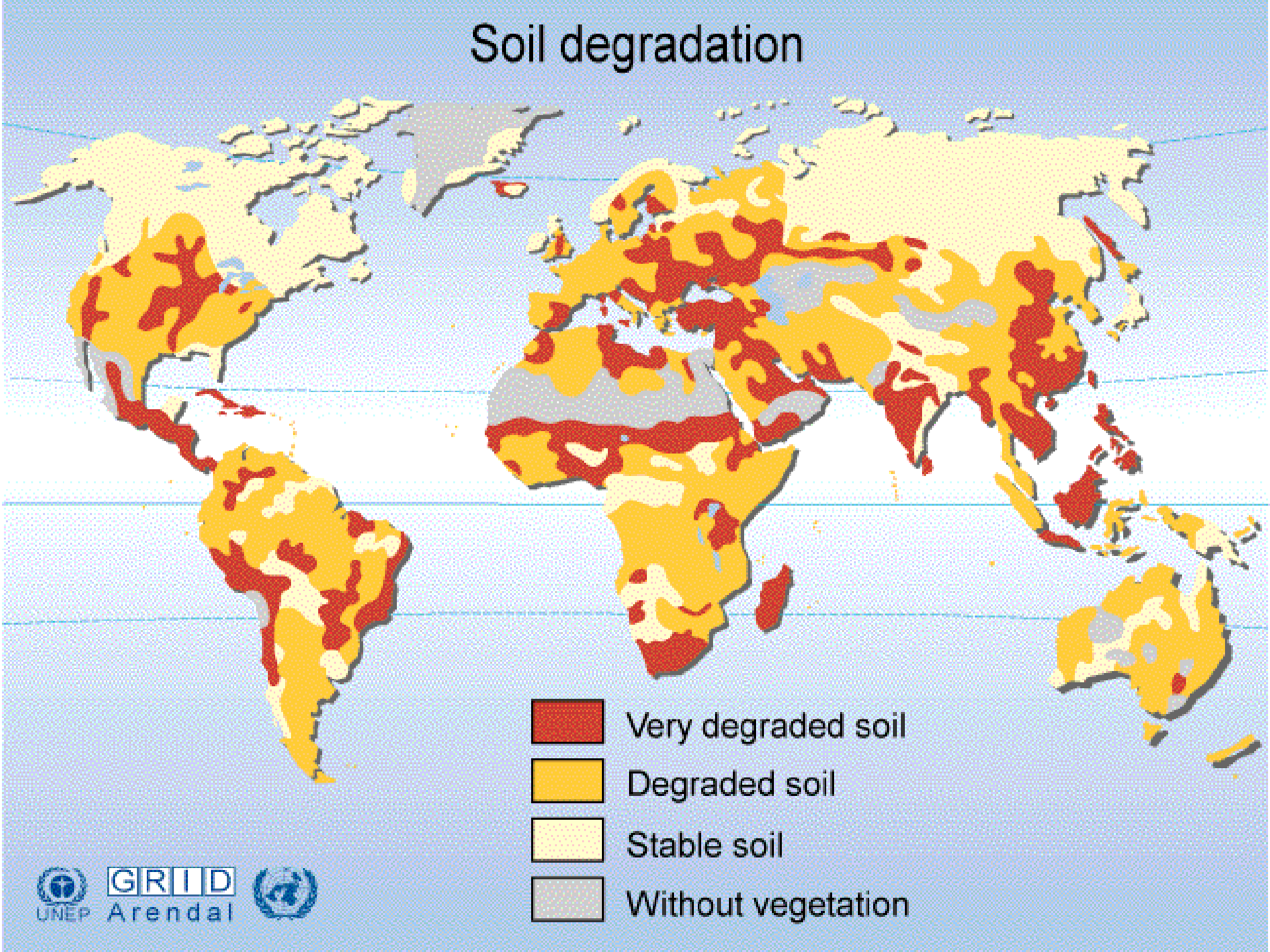
gully erosion: water converges into small streams and takes with it large amounts of soil

DESERTIFICATION

- result from soil degradation and absence of vegetation in arid and semiarid areas
- due to both climate change & human activities

Severe gully erosion in Bolivia. Courtesy FAO

Soil degradation



UNEP GRID Arendal

OVERCULTIVATION & OVERGRAZING

OVERCULTIVATION

- Till and plowing (control weeds and increase crop yield) exposes soil to erosion

STRATEGIES REDUCING OVERCULTIVATION

- no-till or low-till farming: equipment to turn over soil while covering it back up and planting new crops at the same time
- alley cropping: trees planted in strips; crops grown between trees (shelter crops from winds)
- contour farming: crops planted across slopes to slow down water erosion
- strip cropping: planting alternating rows of different crops

OVERGRAZING

- large amounts of livestock (cattle) to graze on arid grasslands

SOIL CASE STUDIES & LEGISLATION

DUST BOWL

- occurred in 1930's in Oklahoma, Texas, Kansas
- caused by plowing prairies
- loss of natural grasses that rooted the soil
- droughts and winds blew most of the topsoil away

1935 SOIL AND CONSERVATION ACT

- established the Soil Conservation Service
- mandates the protection of the nation's soil reserves
- deals with soil erosion, carries out soil surveys and does research on soil salinity

VIDEO: http://videos.howstuffworks.com/hsw/6110-essential-and-endangered-the-dust-bowl-video.htm

TECTONIC PLATES

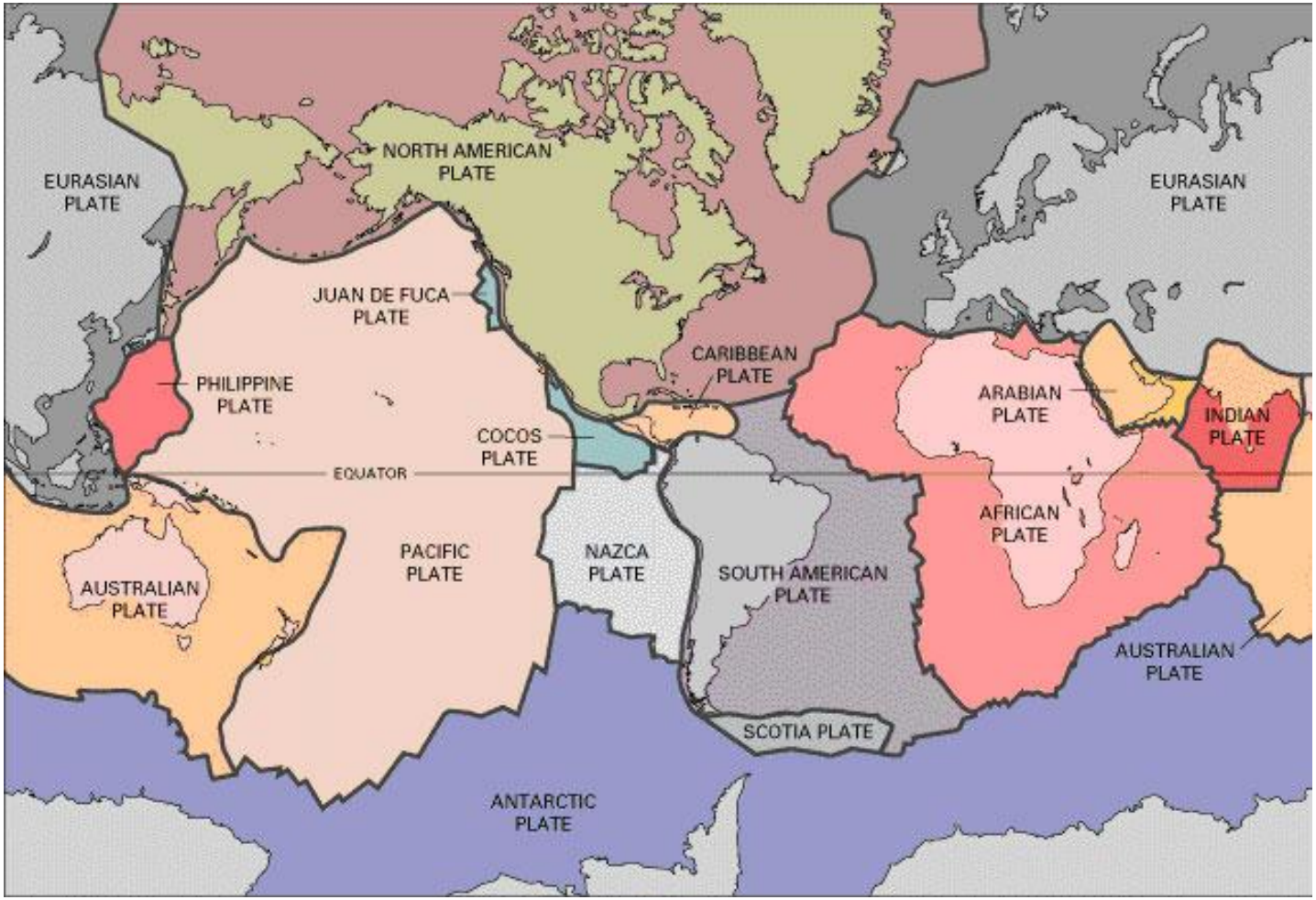


PLATE TECTONICS REVIEW

- CONTINENTAL DRIFT: plates that are underneath continents move; therefore moving the continents
- PLATE BOUNDARIES
  - →convergent: two plates move toward each other and have or will collide
  - →divergent: plates are moving away from each other; cause upwelling of magma and formation of new crust
  - →transform: plates are moving past each other; sideways
  - →subduction zone: one plate is overriding the other one; one plate is forced beneath

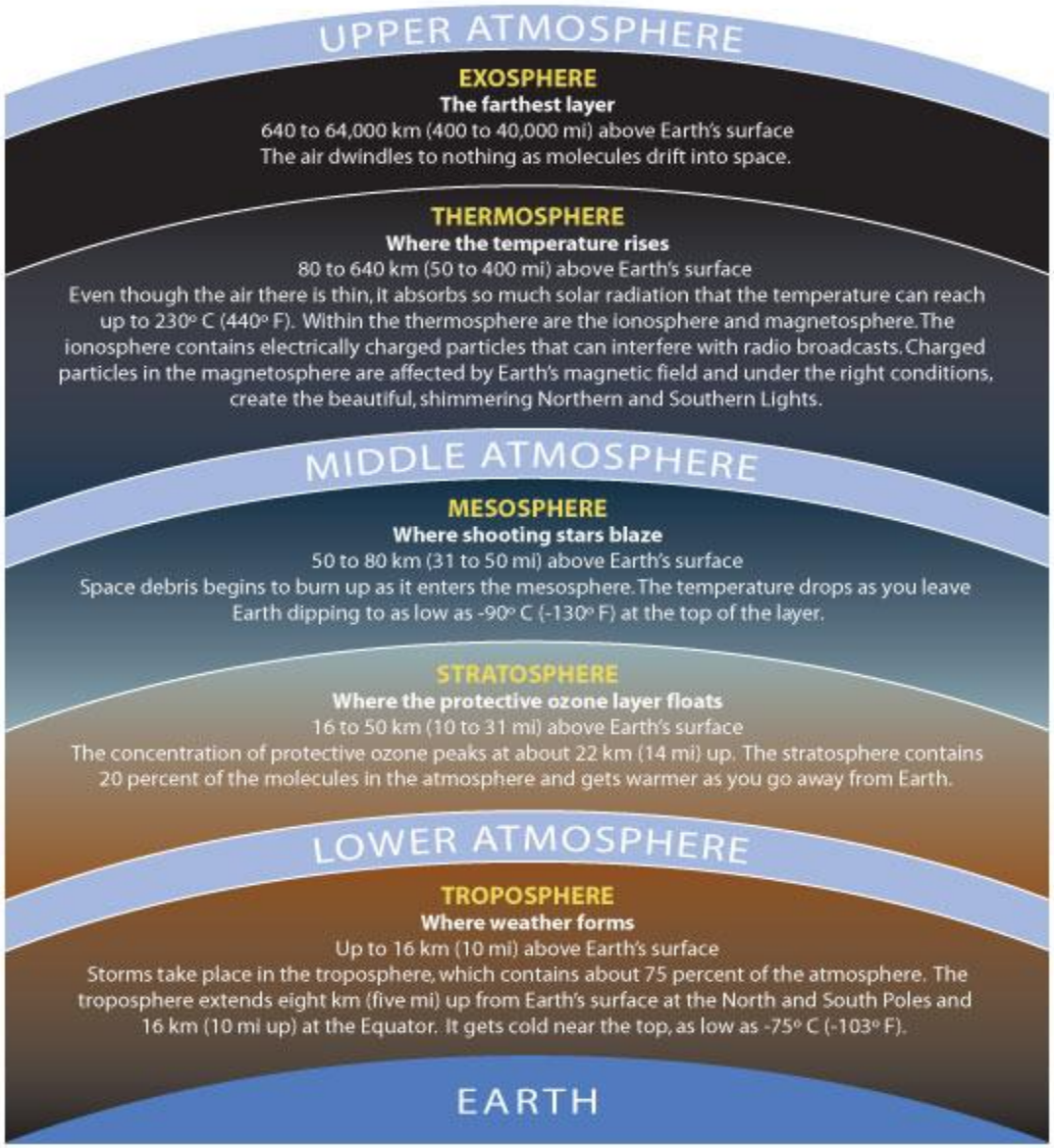
VOLCANOES

- formed by material from earth's interior
- formed where tectonic plated meet
- active vs. dormant

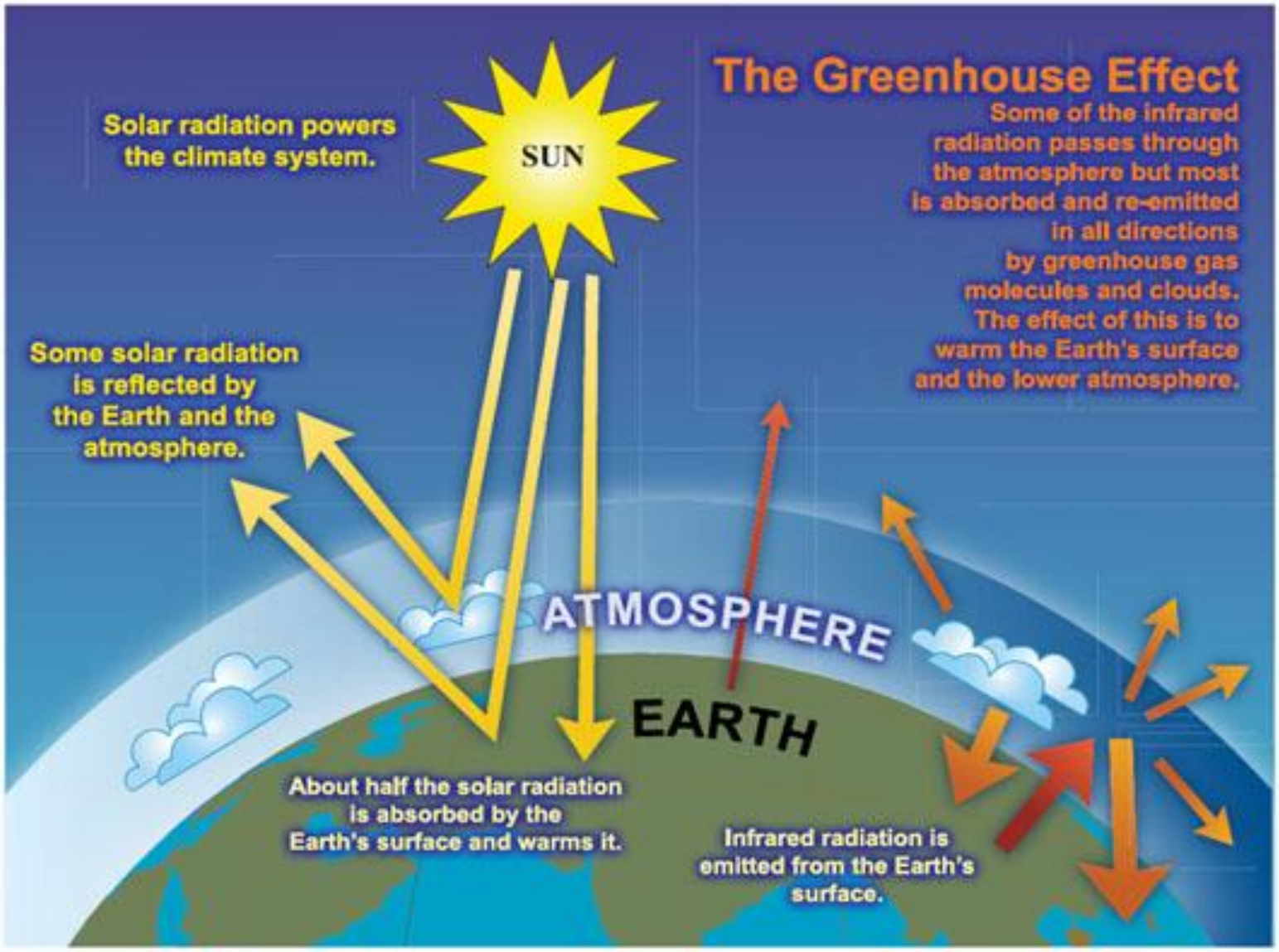
EARTHQUAKES

- result of vibrations (often due to plate movements) deep in the earth that release energy
- often occur at transform boundary

EARTH'S ATMOSPHERIC LAYERS



GREENHOUSE EFFECT



CLIMATE

- long-term(about 30-year span) weather
- important characteristics: temperature and precipitation

AIR CIRCULATION IN THE ATMOSPHERE

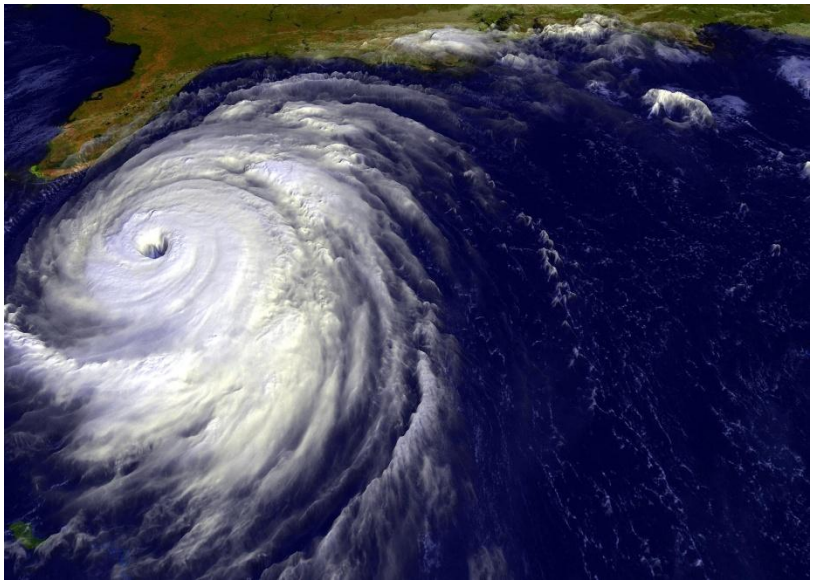
- Earth's surface is heated unevenly
  - → Sun's rays strike the equator directly year long, but the rays heat the N and S poles at an angle (poles receive less sunlight and less intensity)
  - → Earth is tilted on its axis; certain regions of its surface closer to Sun at various times of year
  - → Earth's rotation prevents air masses from moving directly south or north of equator; get deflected to the right in N hemisphere and to the left in S hemisphere (Coriolis Effect)

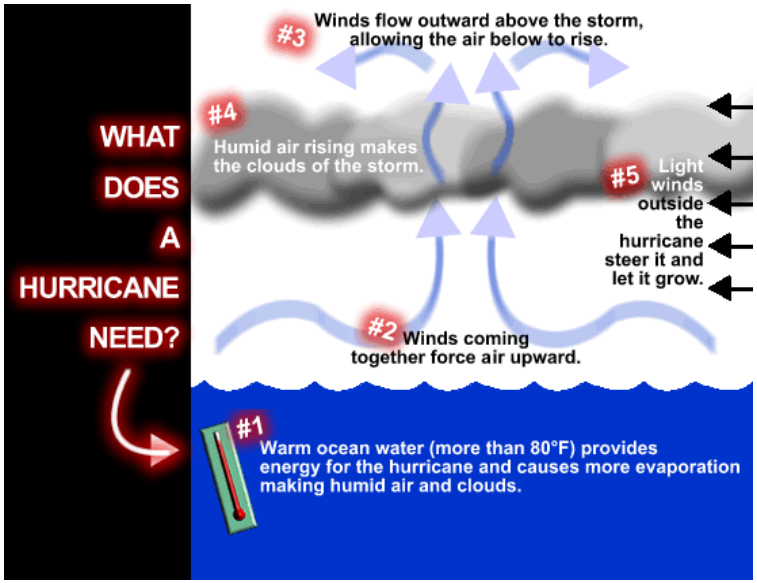
SEVERE WEATHER: MONSOONS

- occur in coastal areas
- hot air rises from heated land
- creates low-pressure

SEVERE WEATHER: HURRICANES

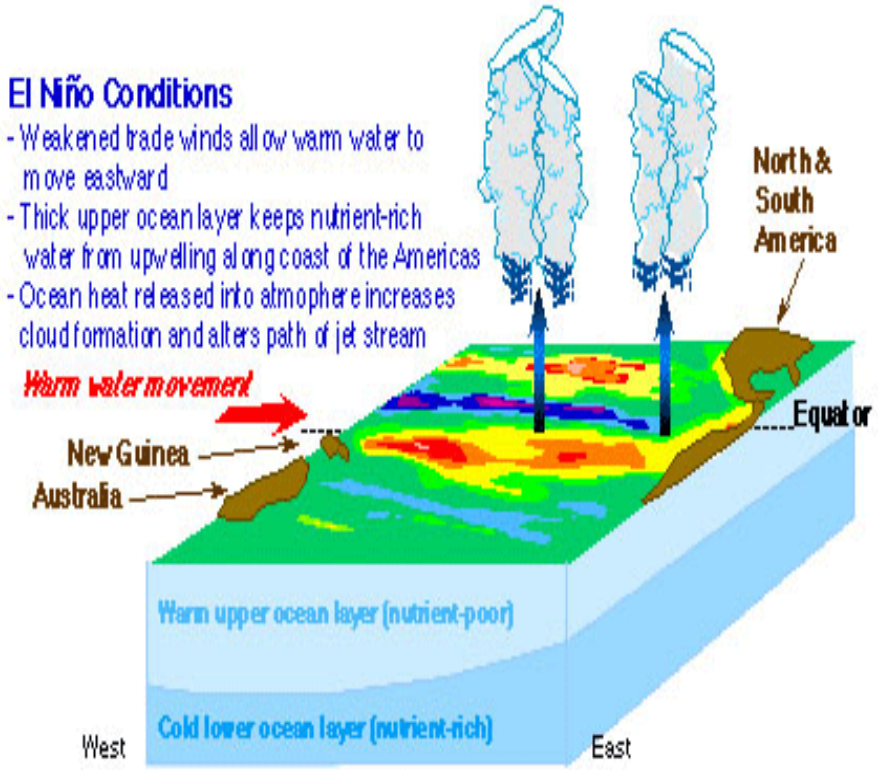
- severe tropical storms
- rotating winds remove water vapor from ocean's surface
- heat energy created by the condensing water vapor





ENSO
EL NINO SOUTHERN OSCILLATION

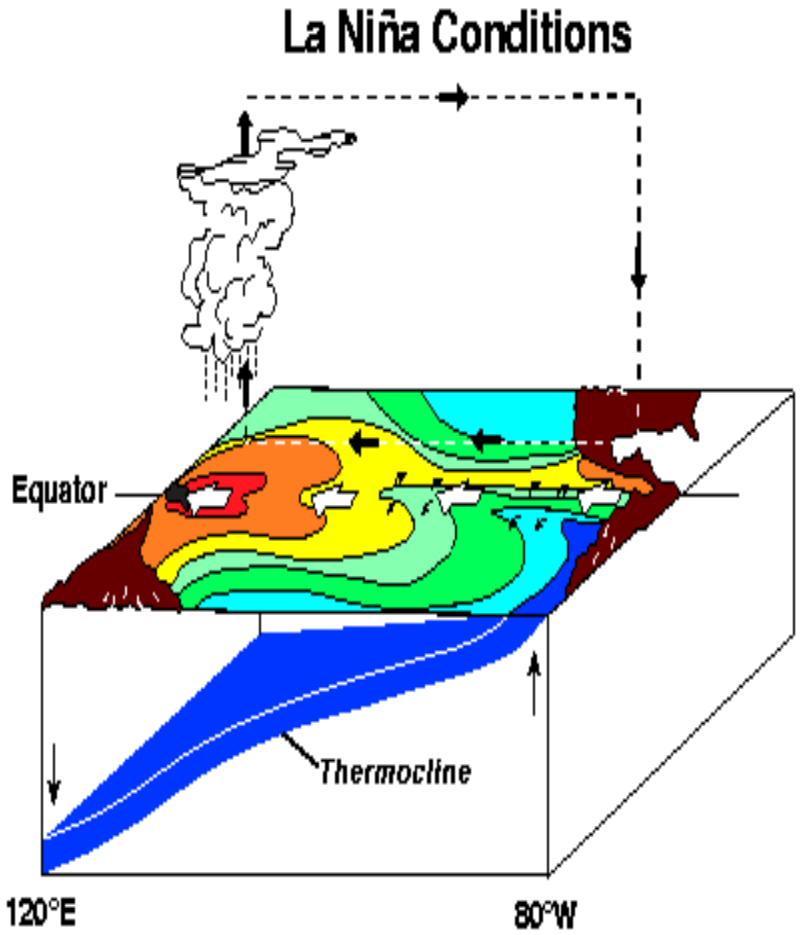
- occurs in late December along west coast of South America
- normal trade winds are weakened or reversed because of a reversal of the high and low pressure regions on either side of the tropical Pacific
- upwelling slows or stops; water off the coast becomes warmer and contains fewer nutrients
- <u>Effect on humans</u>: offshore fish population in some coastal areas declines → decline in shore birds that feed on those fish → economic decline for country (Peru)



CLIMATOLOGICAL EFFECTS OF EL NINO

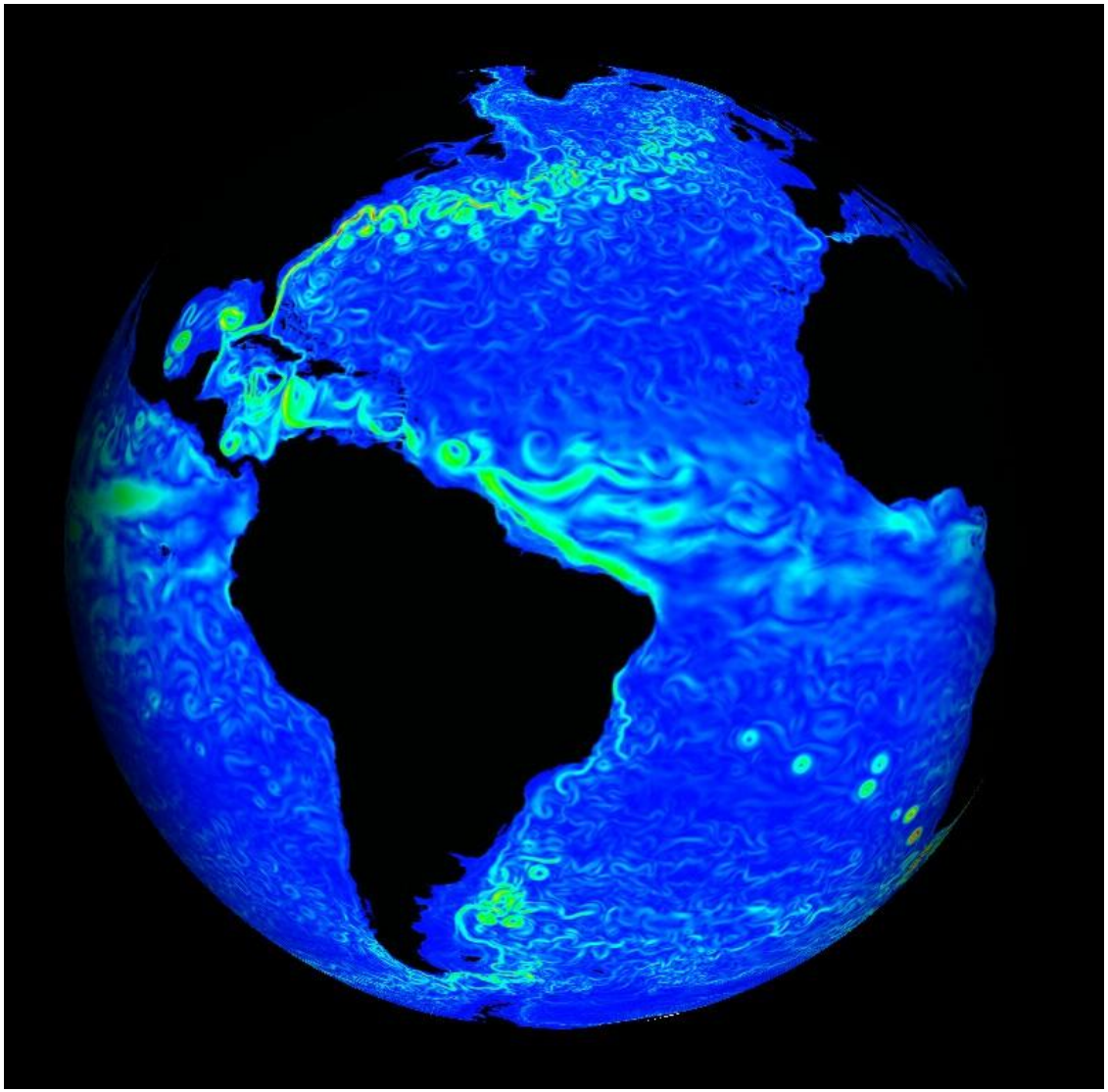
- N. USA and Canada experience warmer winters and less intense hurricane season
- E. USA and regions in Peru & Ecuador that are typically dry have higher than normal rainfall
- Phillipines, Indonesia, Australia are drier than normal

LA NINA

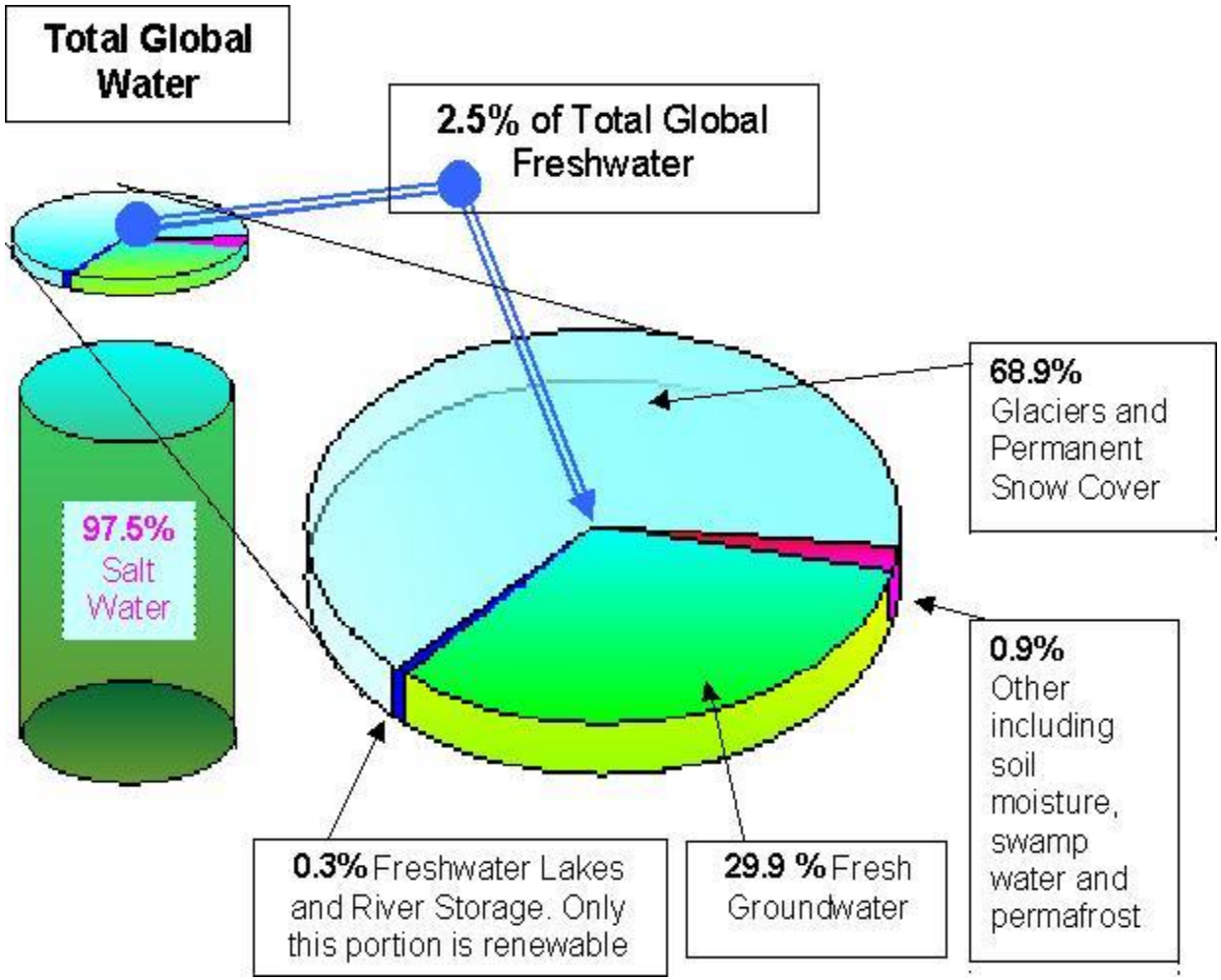


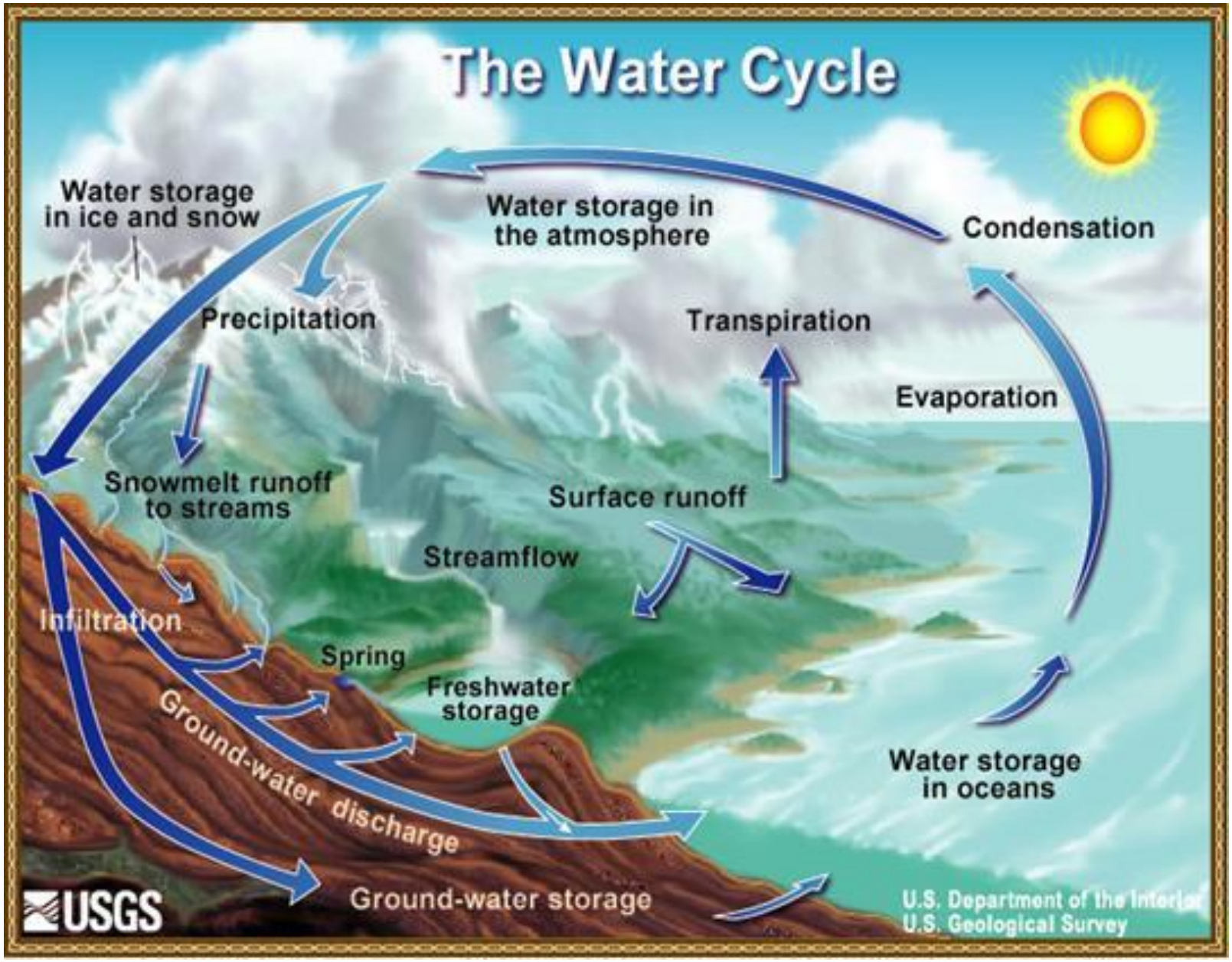
- reverse of El Nino
- cold ocean temperatures in eastern equatorial Pacific
- Wetter-than-normal conditions across Pacific N.W. and dryer and warmer-than-normal conditions in S.E. USA
- responsible for increase in hurricanes & heavier-than-normal monsoons in India and S.E. Asia

THE HYDROSPHERE
WATER 75% OF EARTH'S SURFACE

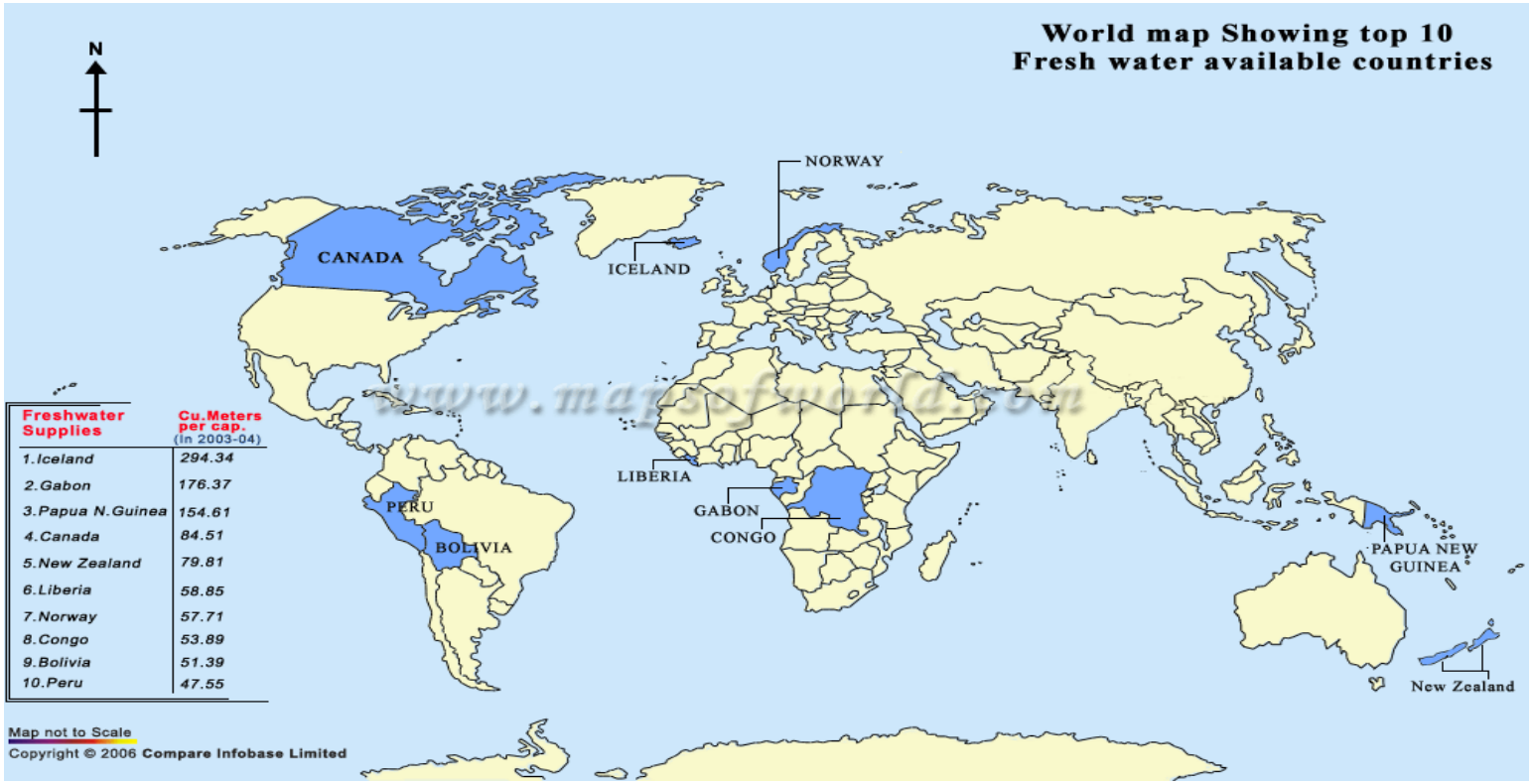


GLOBAL WATER AVAILABILITY




The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Precipitation
Transpiration
Evaporation
Snowmelt runoff to streams
Surface runoff
Streamflow
Infiltration
Spring
Freshwater storage
Ground-water discharge
Water storage in oceans
Ground-water storage
USGS
U.S. Department of the Interior
U.S. Geological Survey

FRESHWATER



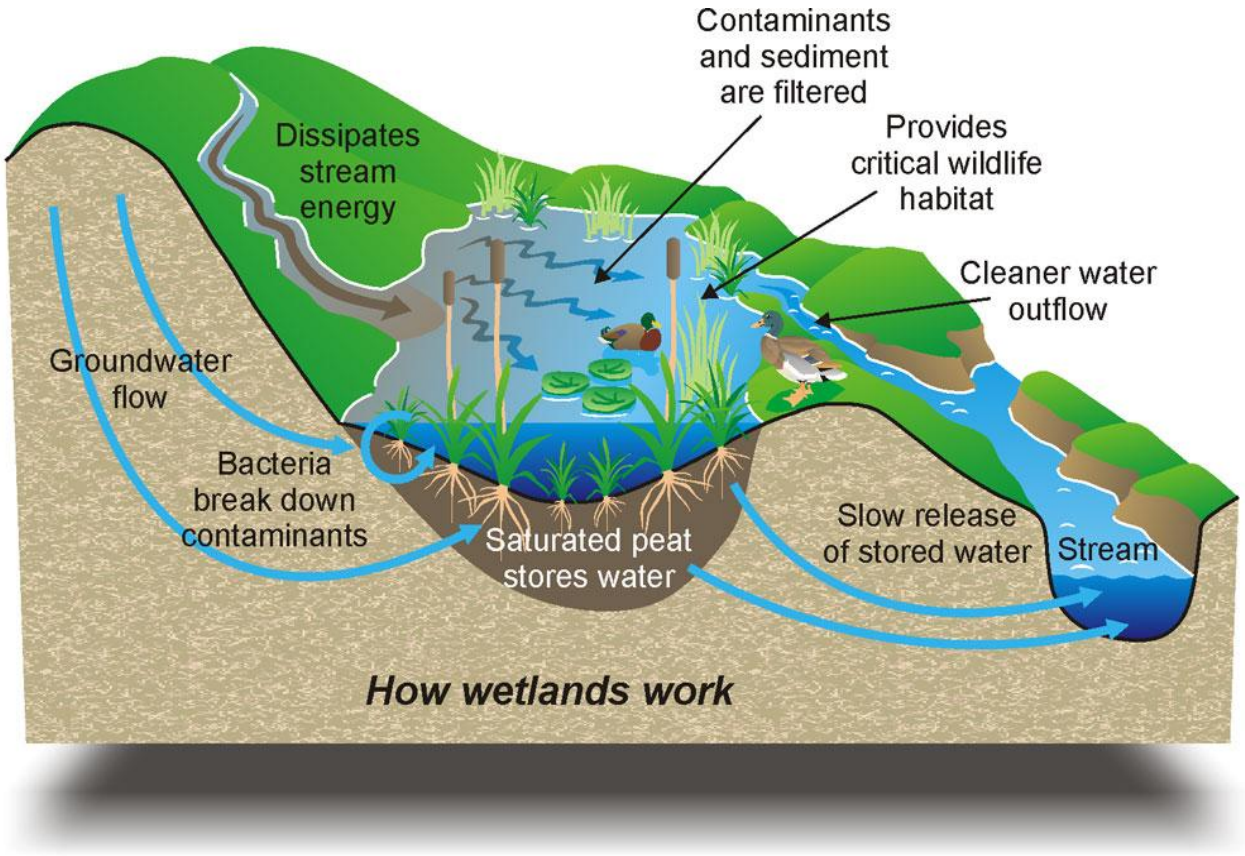
- deposited on earth through precipitation
- groundwater: water that moves through soil into wells/aquifers
- surface water flows to form stream → river → flows to ocean
- watershed: land area that drains into a particular stream
- freshwater on land shaped the earth's surface (erosion)

FRESHWATER BODIES: ESTUARIES

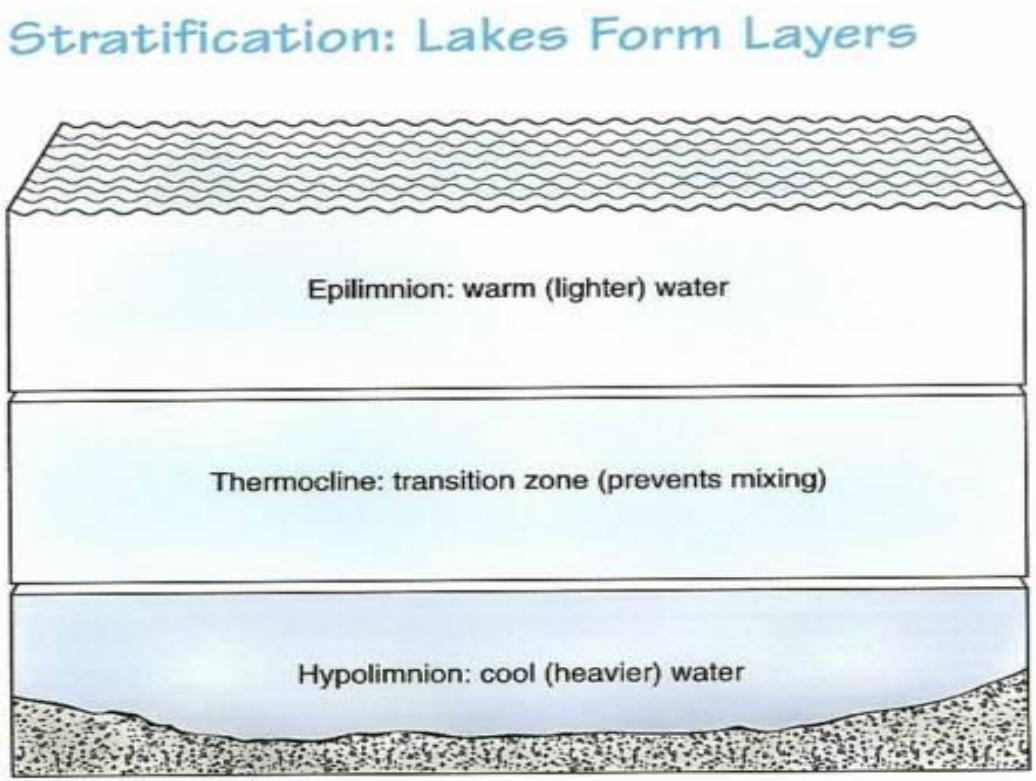
- AKA salt water marshes, mangrove forests, inlets, bays, and river mouths
- enclosed coastal body of water with thousands or more rivers or streams flowing into it
- free connection to open sea
- rich with animal and plant species
- shallow, warm water
- VIDEO: http://www.sjrwmd.com/video/flv/WhatsanEstuaryNowYouKnow.html

FRESHWATER BODIES: WETLANDS

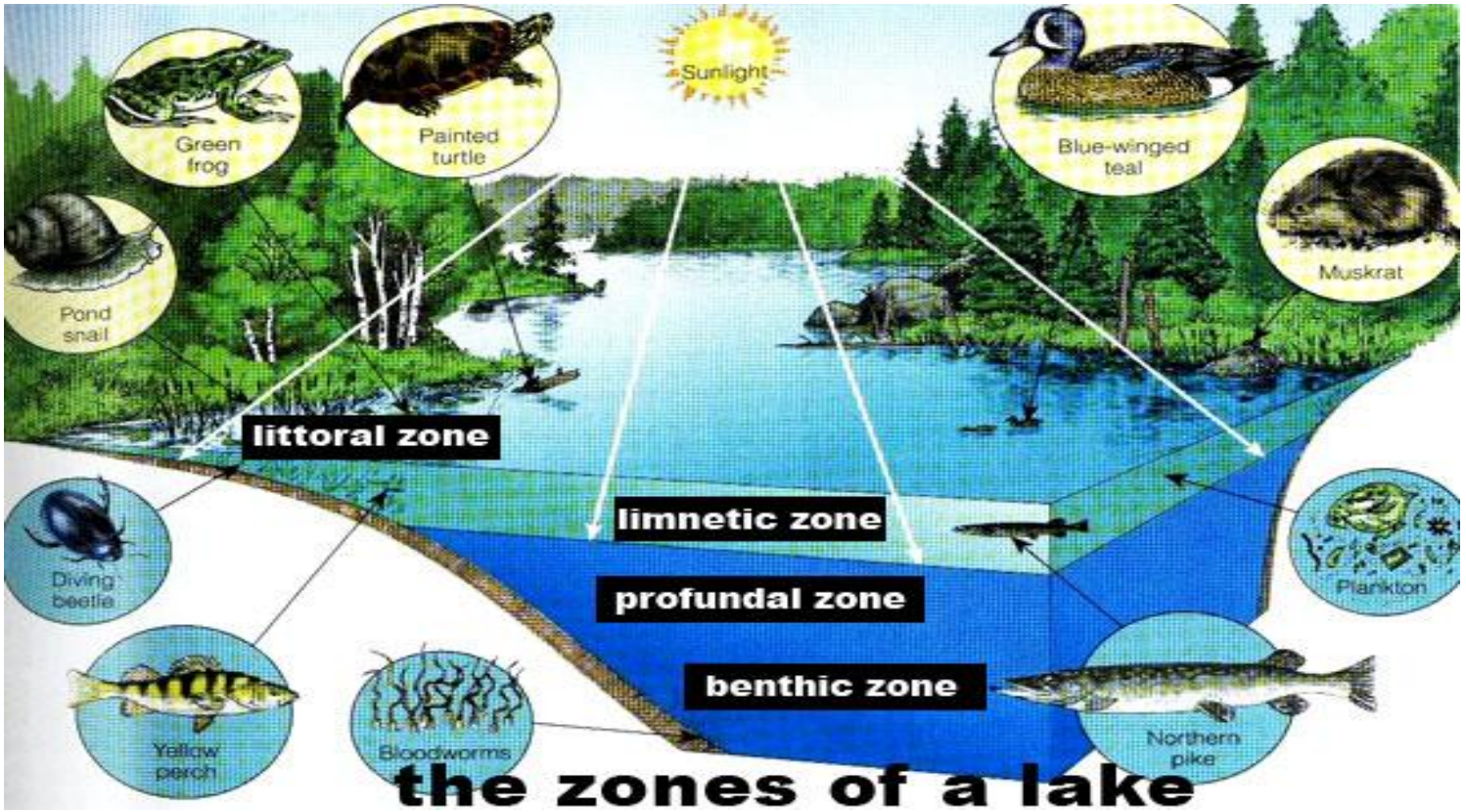
- AKA marshes, swamps, bogs, prairie potholes, floodplains



FRESHWATER BIOMES: STRATIFICATION



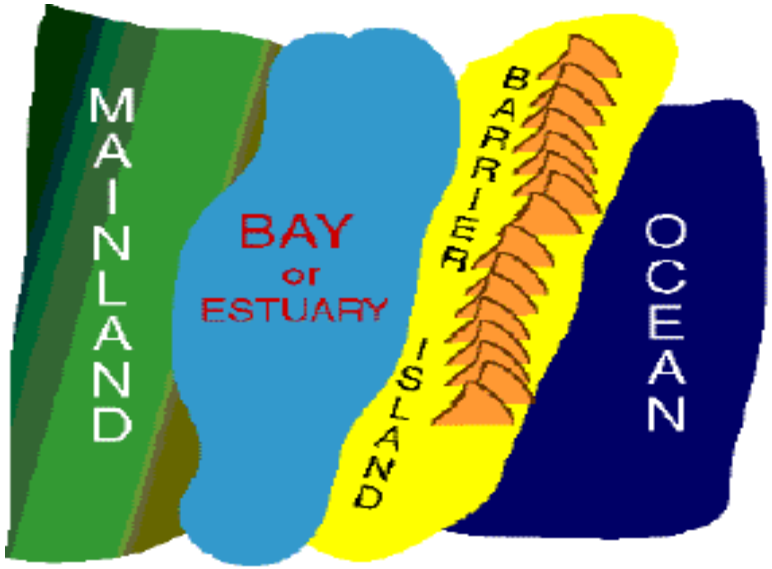
Lakes in the temperature climates tend to form layers. The epilimnion is roughly equivalent to the zone of light penetration where the bulk of productivity, or growth, occurs. The thermocline is a narrow band of transition which helps to prevent mixing between the layers. The hypolimnion is the zone of decomposition, where plant material either decays or sinks to the bottom and accumulates.



- littoral zone: abundant sunlight; at end rooted plants stop growing
- limnetic zone: surface of open water; short-lived organisms that rely on photosynthesis
- profundal zone: too deep for sunlight to penetrate (aphotic); no photosynthetic organisms are found
- benthic zone: deepest layer; very low temperature and low oxygen levels

SALTWATER ECOSYSTEMS: BARRIER ISLANDS

- created by buildup of deposited sediment
- boundaries are constantly shifting as water moves around them
- acts as buffer for shoreline behind them



SALTWATER ECOSYSTEMS: CORAL REEF

- vulnerable to physical stresses, changes in light intensity and changes in water temperature
- home to diverse organisms

OCEAN ZONES

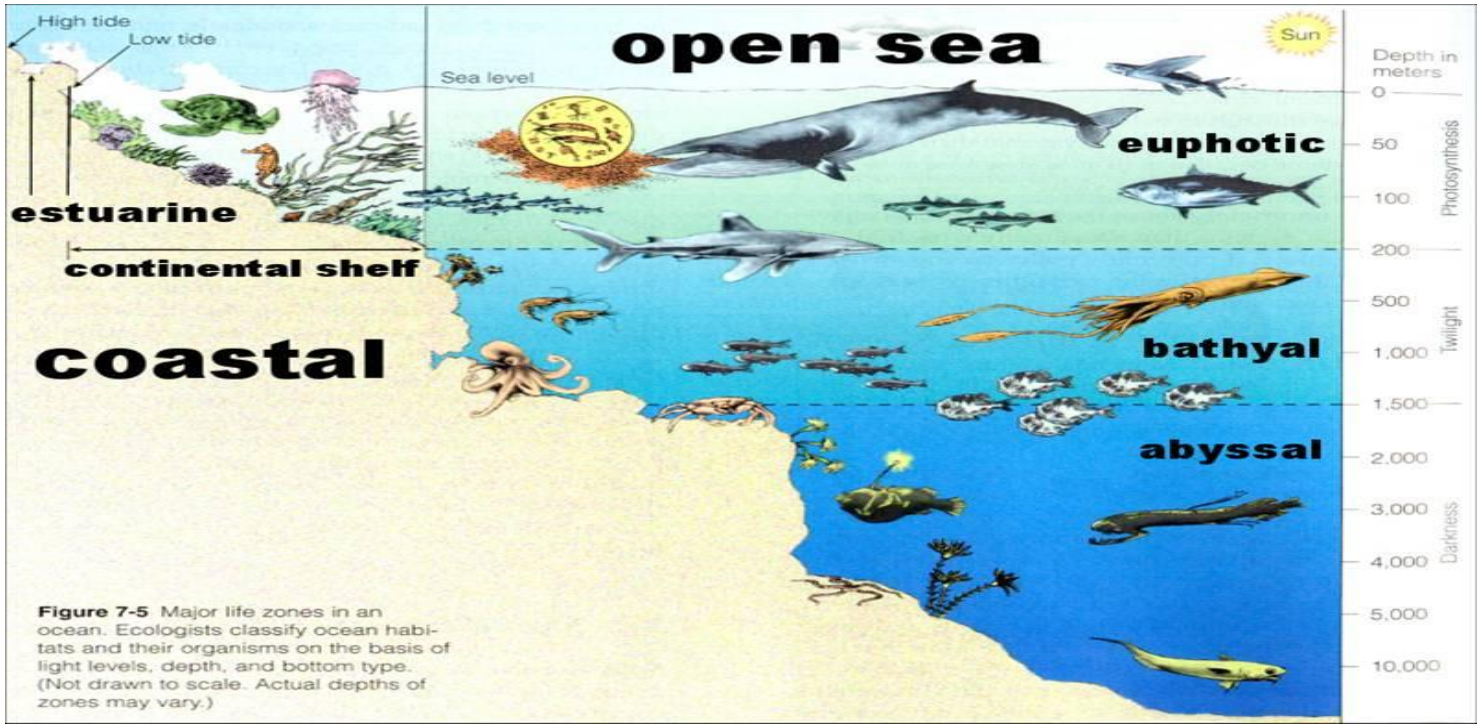


Figure 7-5 Major life zones in an ocean. Ecologists classify ocean habitats and their organisms on the basis of light levels, depth, and bottom type. (Not drawn to scale. Actual depths of zones may vary.)

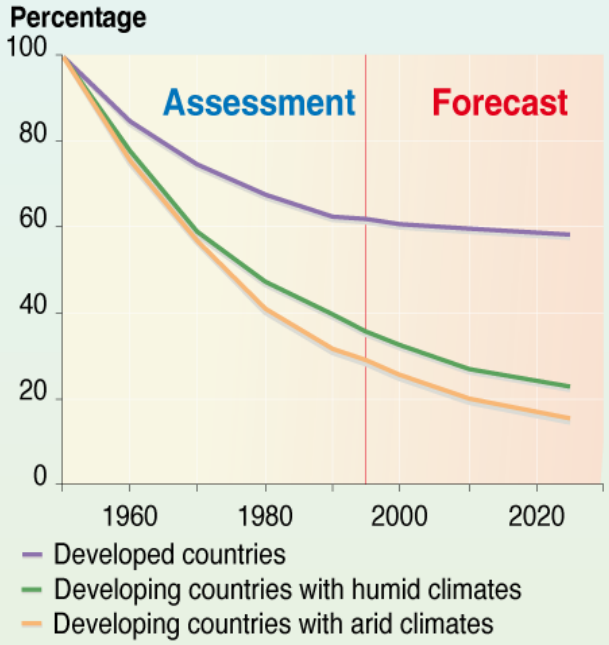
- euphotic: photic, upper layers, warmest region, highest level of DO
- bathyal: middle, insufficient light for photosynthesis; colder
- abyssal: deepest region, cold temperature very low DO; high level of nutrients (decomposition)

WATER: A RESOURCE TO MANAGE, A THREAT TO CONTROL

- Major global uses of freshwater:
  - →70% irrigating crops (agriculture)
  - →20% industry (power plants, etc.)
  - →10% direct human use (bathing, cooking, etc.)
- Global Water Needs
  - →water stressed: renewable annual water supply of about 1,000 to 2,000 m^3 per person
  - →water scarce: less than 1,000 m^3 per person
    - developing countries w/rapidly increasing population
    - EX: Algeria, Egypt, Libya, Kenya, Rwanda, Israel, Jordan, Saudi Arabia, Singapore, Barbados, Morocco…

WATER AVAILABILITY:
DEVELOPED VS. DEVELOPING COUNTRIES

Water Availability Trends



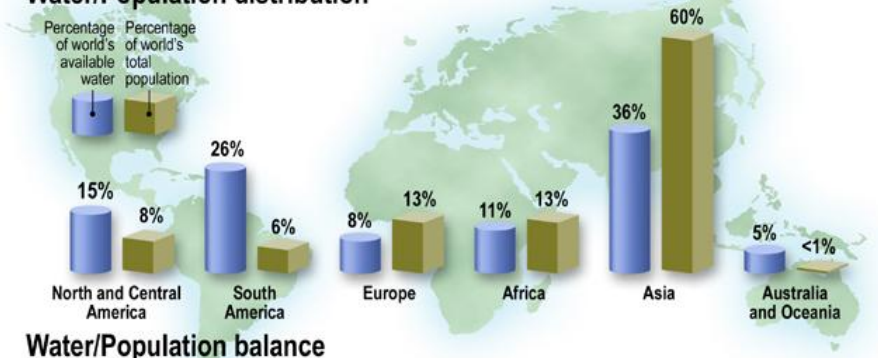
Water availability in developing countries (with and without arid climates) has declined by about 65 percent since the 1960s and continues to do so.

Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, Saint Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO),1999; World Resources Institute (WRI), Washington DC, 1998.

Water availability versus population

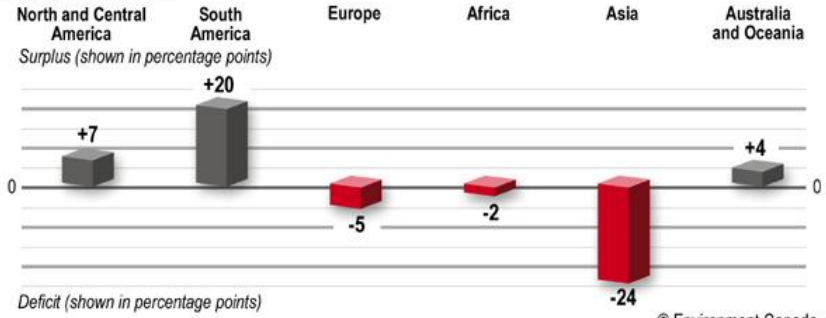
Although 60% of the world's population live in Asia, the continent has only 36% of the world's water resources. Here's how Asia compares to other regions.

Water/Population distribution



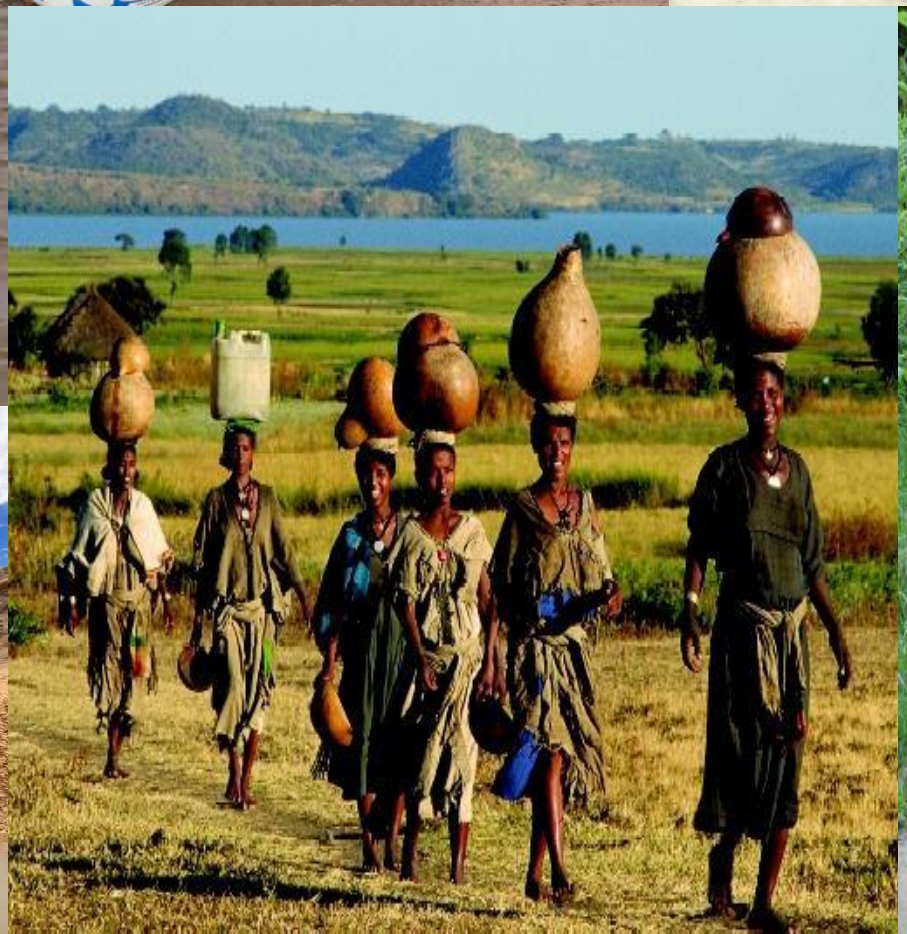
Water/Population balance

A region's water/population balance is determined by the difference between its proportion of the world's available water and its proportion of the world's population. A surplus indicates that its proportion of the world's available water is greater than its proportion of the world's population. A deficit indicates the reverse situation.









WATER SHORTAGE SOLUTIONS

- INTERBASIN TRANSFER
  - →water is transferred long distance (aqueducts, pipes) from its source
  - →cons: arguments over water rights, may increase salinity of water & change climate

- GROUNDWATER PUMPING/TAPPING
  - →sources: wells/aquifers
  - →cons: depressed water table, drying up local groundwater sources, compacted aquifer, over-construction can make soil impermeable
  - →EX: Biscayne Aquifer, Florida

DAMS: TRAPPING & STORING WATER

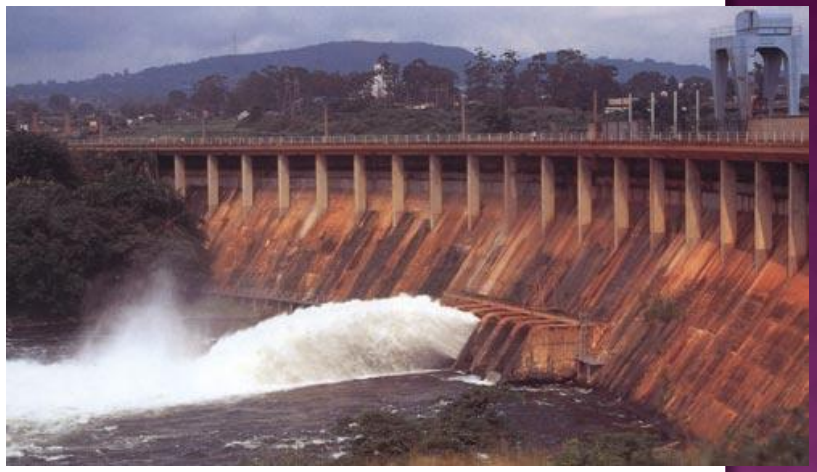
- PROS
  - → store rain water or river water
  - → produce energy
  - → control flooding

- CONS
  - → loss of fish & others (salmon) that migrate upstream to spawn
  - → flooding of areas not previously underwater
  - → loss of biodiversity
  - → raising of salt concentration in estuaries (restricts flow of freshwater downstream)
  - → Loss of nutrient-rich sediments (silt) downstream

WATER CONSERVATION INCREASING FRESHWATER

- Changes in personal habits
- Construct dams & reservoirs
- Desalinate water (low rate of production, expensive)
- Drip irrigation (reduces evaporation)
- Education
- Xeriscaping (planting crops that require little water)
- Rebates/legislation on low-water use items(low-flush toilets)
- Reduce government subsidies (increase water cost)
- Reprocess/recycle water (gray water used for irrigation, requires separate pipeline)

CASE STUDY
ASWAN DAM, EGYPT



- completed in the 1970s
- built to supply irrigation water
- loss of water due to evaporation & seepage in unlined canals
- elimination of nutrients onto farmlands
- depletion of nutrient in Mediterranean caused decline in fish catches
- Increase in standing water → increase in snail population → schistomiasis disease

CASE STUDY: COLORADO RIVER BASIN

- diversion of water from Colorado River
- disputes b/w California, Arizona & Mexico
- trap silt & reduce nutrient levels in farmlands below the dam
- excess salt in soil, soil salinization

CASE STUDY: JAMES BAY (CANADA)

- diversion of rivers into Hudson Bay to generate electrical power
- massive flooding (1 flood =10,000 caribou drowned)
- mercury leached out of rocks and into water

CASE STUDY: OGALLALA RIVER

- underlines 8 states from Texas to North Dakota
- overpumping of groundwater has led to water shortages

CASE STUDY: THREE GORGES DAM (CHINA)

- hydroelectric river dam
- largest dam in world
- PROS: flood control, emission reduction
- CONS: relocation, threaten rivers wildlife, disrupt flow of silt

WATER LEGISLATION

- WATER RESOURCES PLANNING ACT (1964)
  - → plans to formulate & evaluate water/land resource projects
  - → maintain adequate water supplies in USA
- CLEAN WATER ACT (1972 & 1987)
  - → sets & maintains the chemical, physical & biological integrity of nation's water
  - → regulates discharge of pollutants
- SAFE DRINKING WATER ACT (1974)
  - → protect the quality of drinking water in USA
  - → focuses on ground or underground sources of water
- WATER RESOURCES DEVELOPMENT ACT (1986)
  - → establishes & maintains dam safety programs