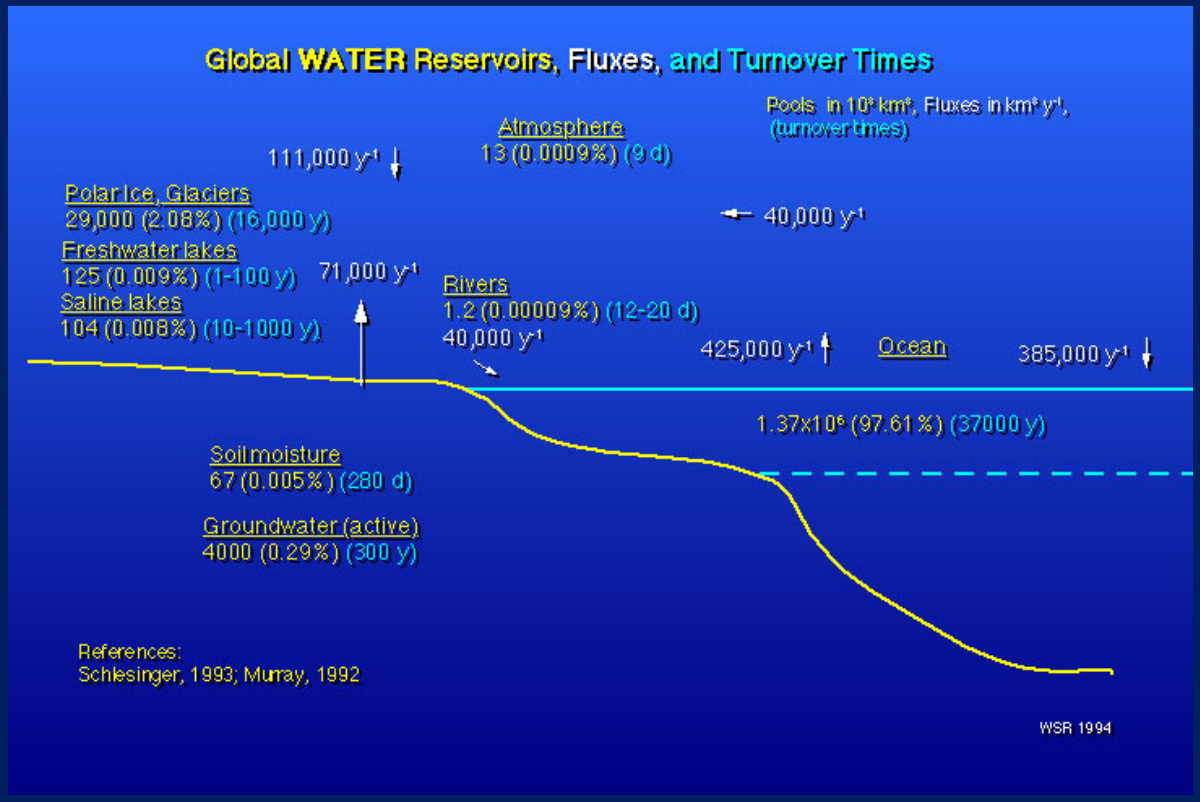
GEO335
HYDROGEOLOGY

HYDROLOGIC EQUATION

A quantitative means of evaluating the hydrologic cycle.



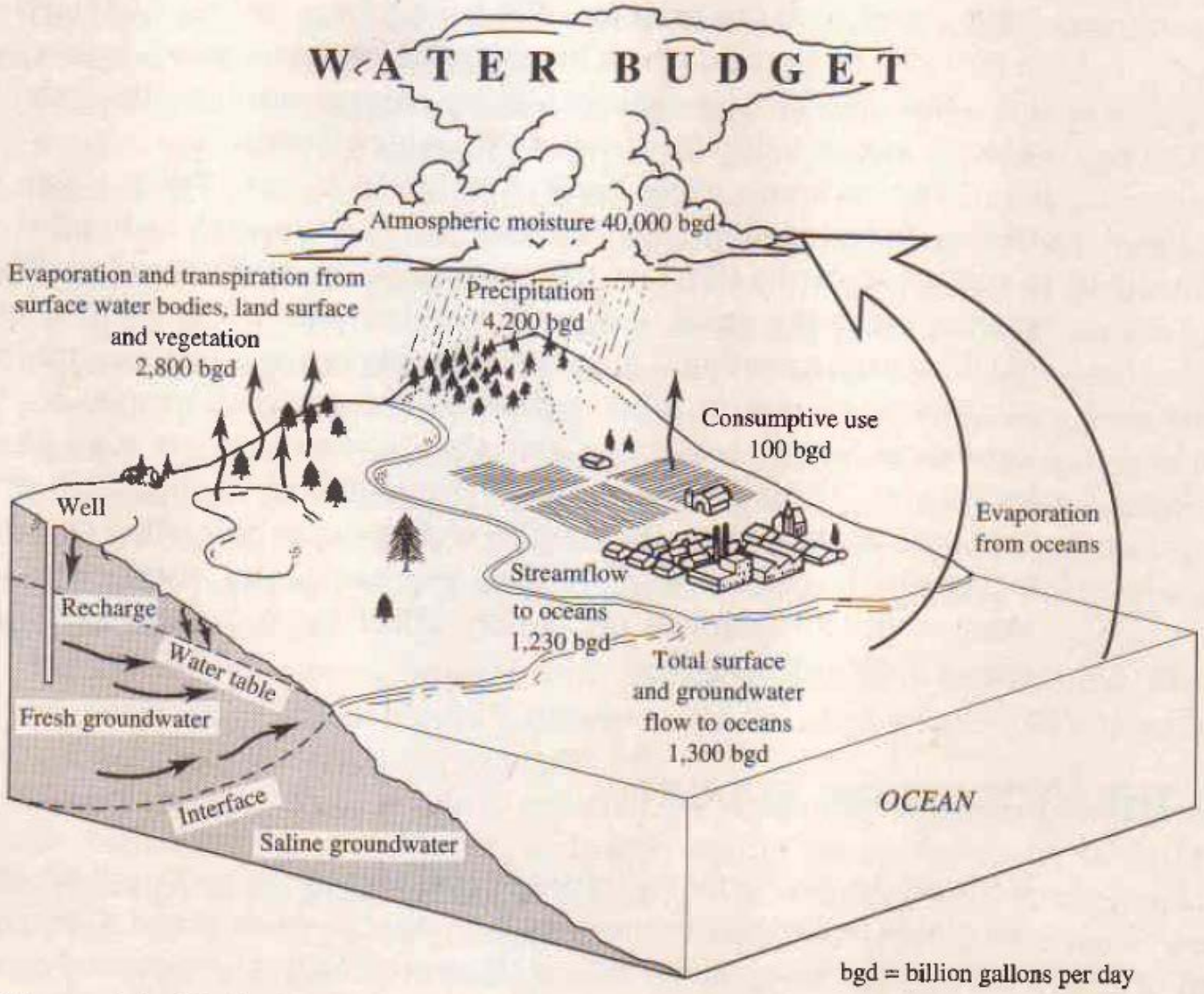
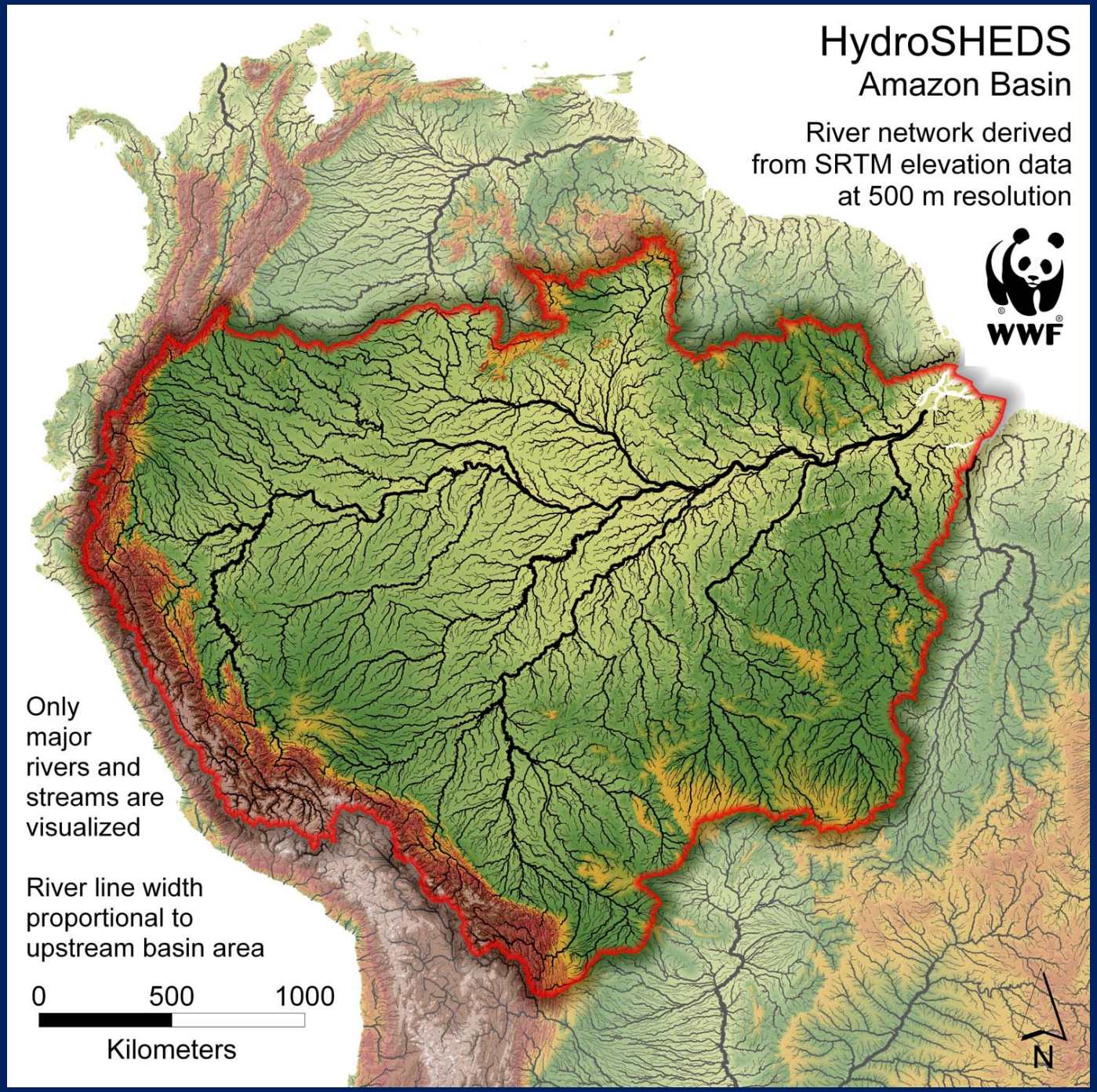
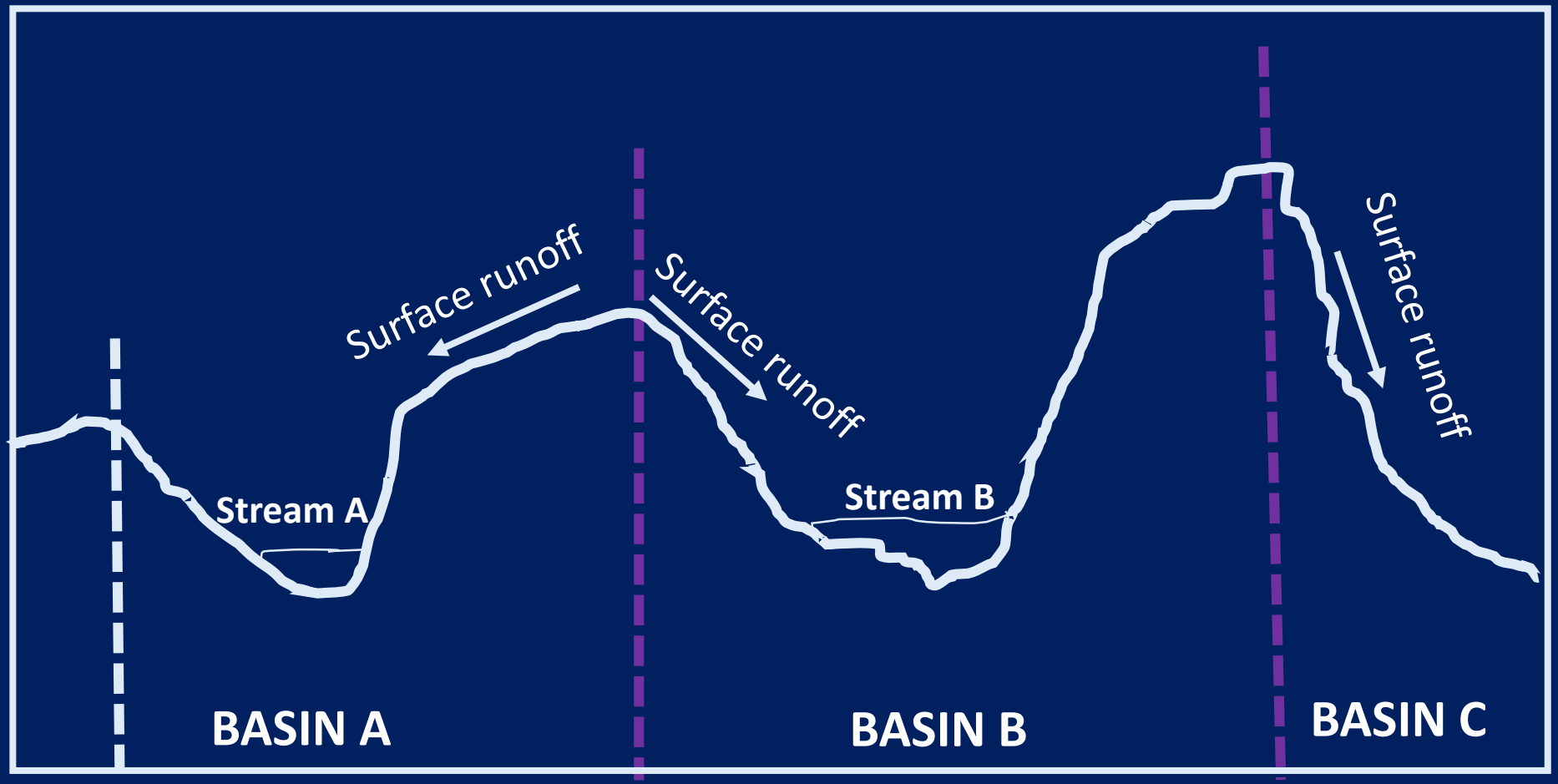


Figure 1.1 Hydrologic budget of coterminous United States. (U.S. Geological Survey.)


HydroSHEDS
Amazon Basin
River network derived
from SRTM elevation data
at 500 m resolution
WWF
Only
major
rivers and
streams are
visualized
River line width
proportional to
upstream basin area
0
500
1000
Kilometers
N

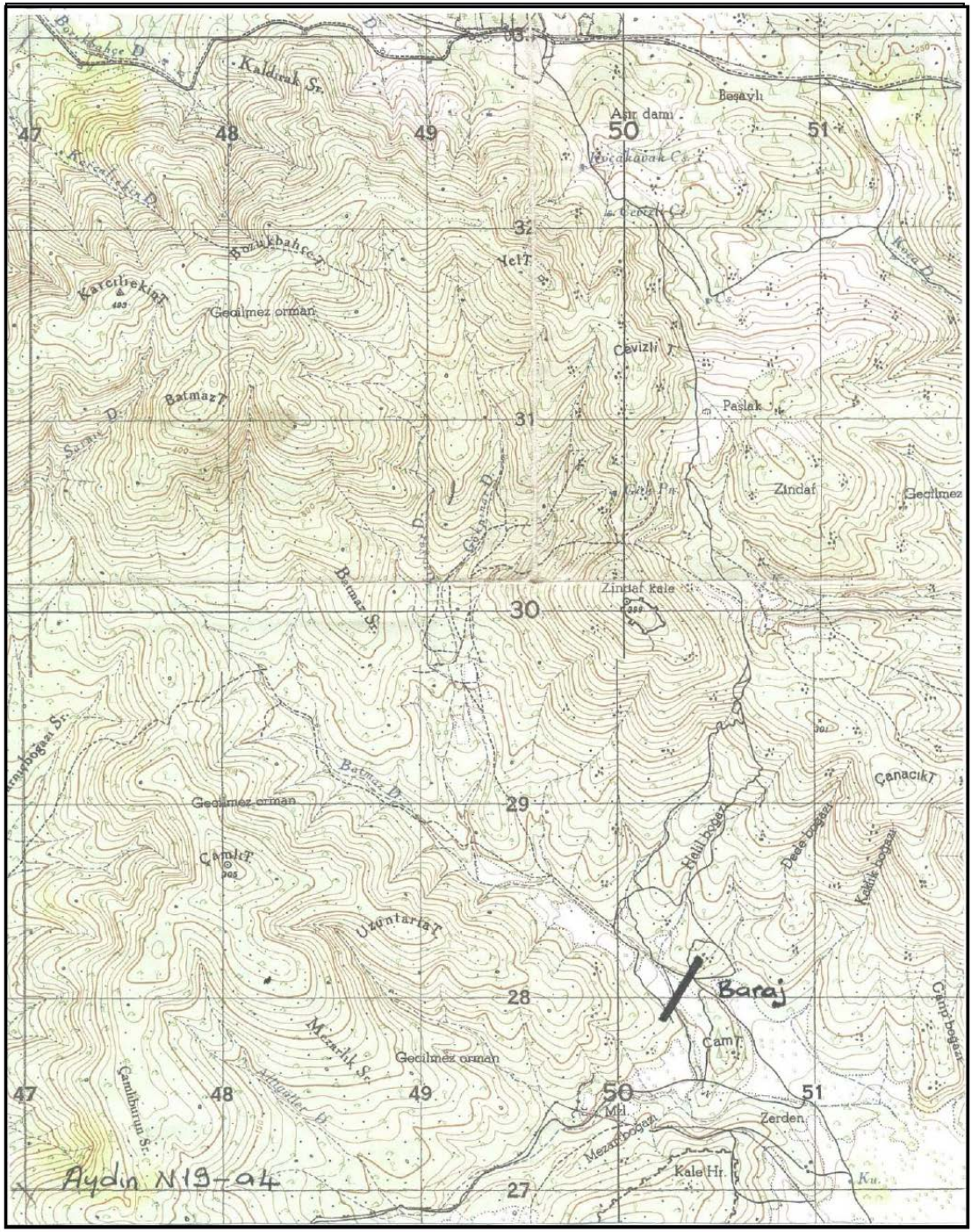

Surface runoff
Surface runoff
Surface runoff
Stream A
Stream B
BASIN A
BASIN B
BASIN C

HOMEWORK 1

Construct the drainage area of a dam shown in the figure. Draw another area by following 150 m contour. This will be the maximum water level inside the dam.

If the average yearly precipitation in the area is recorded as 410 mm/year, how much time should pass before the water level inside the dam reaches 40 m.

Note: Let's assume that there are no additional inflows to or outflows from the drainage area. Evaporation is neglegible.



The drainage area of Köprüören Basin is 275 km^2, the dam lake area is 4.35 km^2. According to measurements carried out in Kütahya Meteorological station, the yearly average precipitation to the area is 525 mm. If approximately 65% of precipitation is lost to evapotranspiration and there is an outlow of $40x10^6$ m^3/year, calculate the time required for the water level inside the dam lake to reach 20 m.

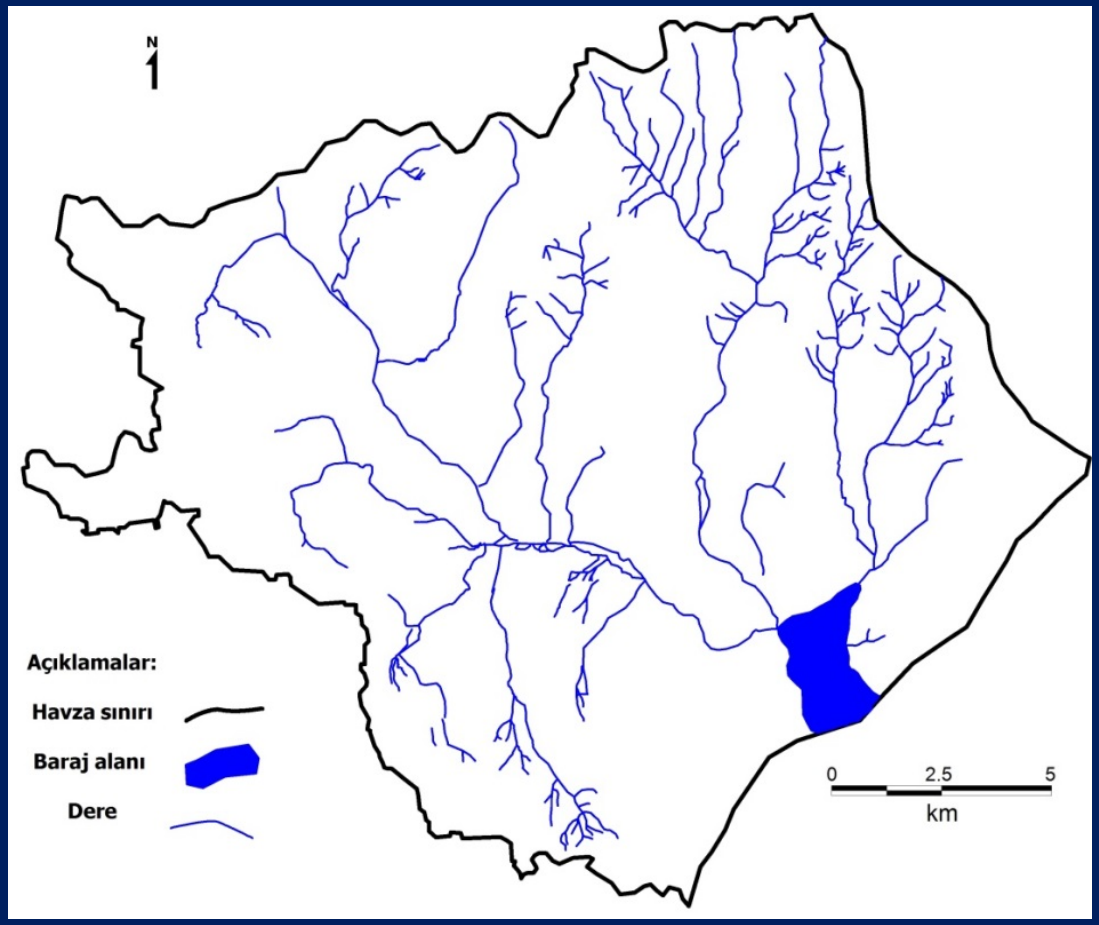
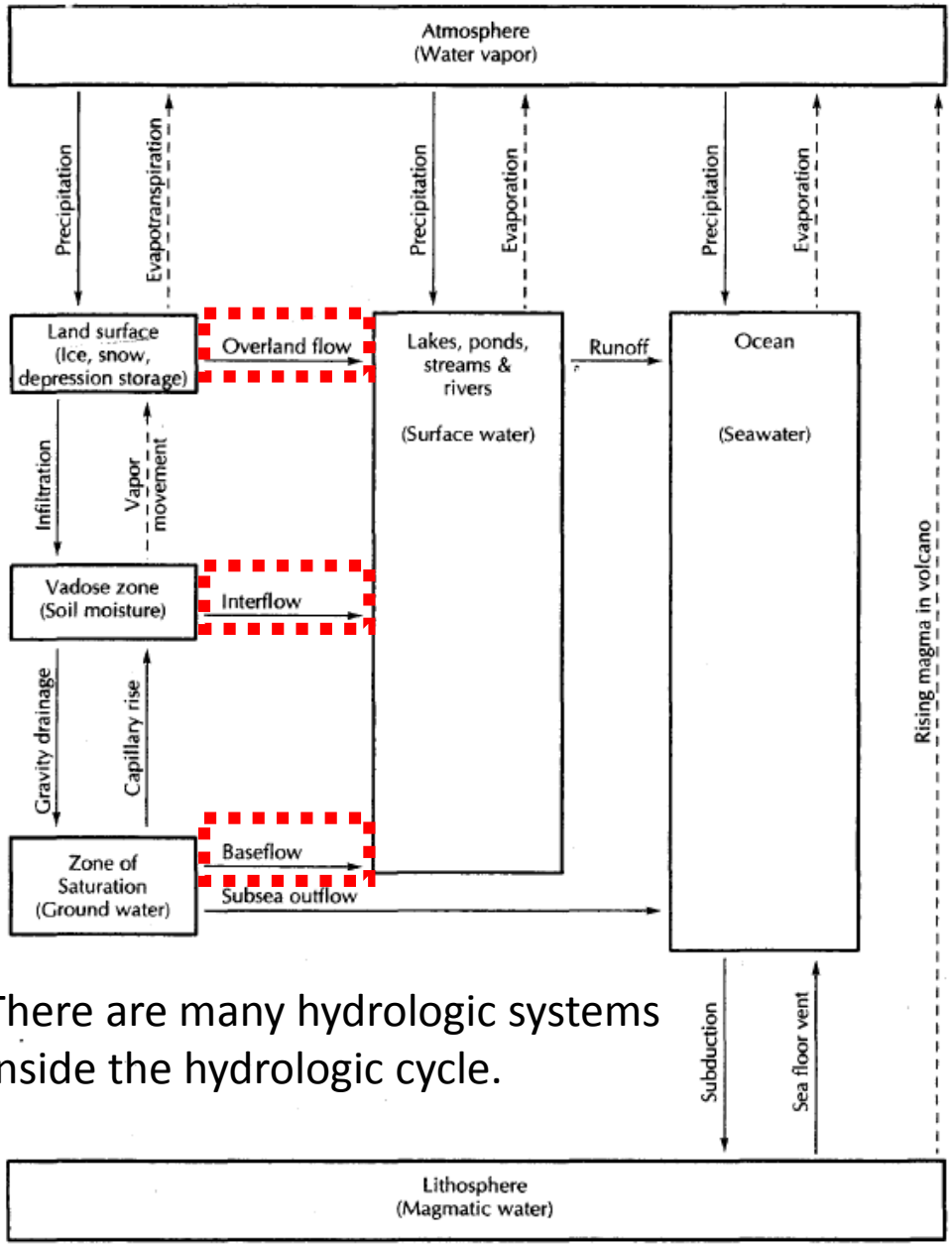


Figure 1. Drainage area of Köprüören Basin (Kütahya)



▲ FIGURE 1.4
Schematic drawing of the hydrologic cycle. Movement of liquid water is shown by a solid line and movement of water vapor is shown by a dashed line.

There are many hydrologic systems inside the hydrologic cycle.

Movement of liquid water →

Movement of water vapor ⇢

Hydrologic equation (law of mass conservation):

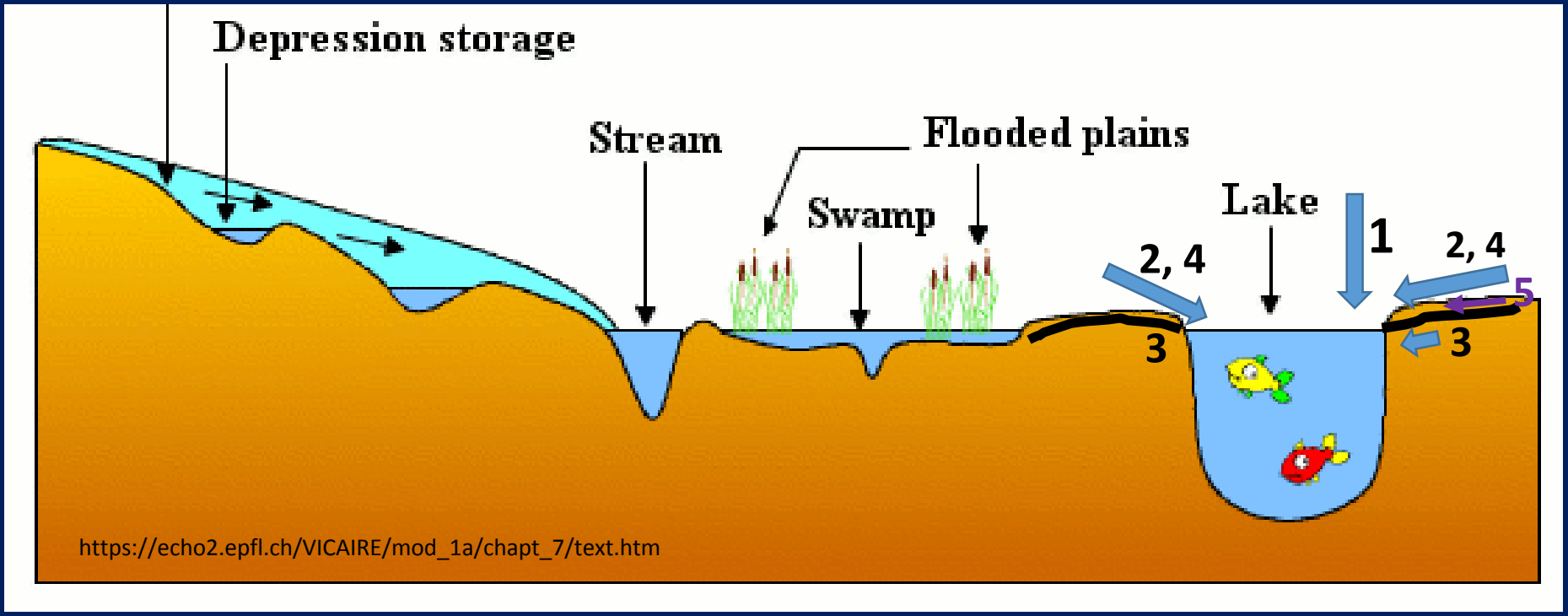
Inflow= outflow ± changes in storage

Fetter, C.W., Applied Hydrogeology

Let's consider a lake as a hydrologic system.

- A lake has a certain volume of water at a given time.

- Inflows add to this water volume: [precipitation that falls on the lake surface (1), streams that flow into the lake (2), groundwater that seeps into the lake (3), interflow (5), overland flow (4)]



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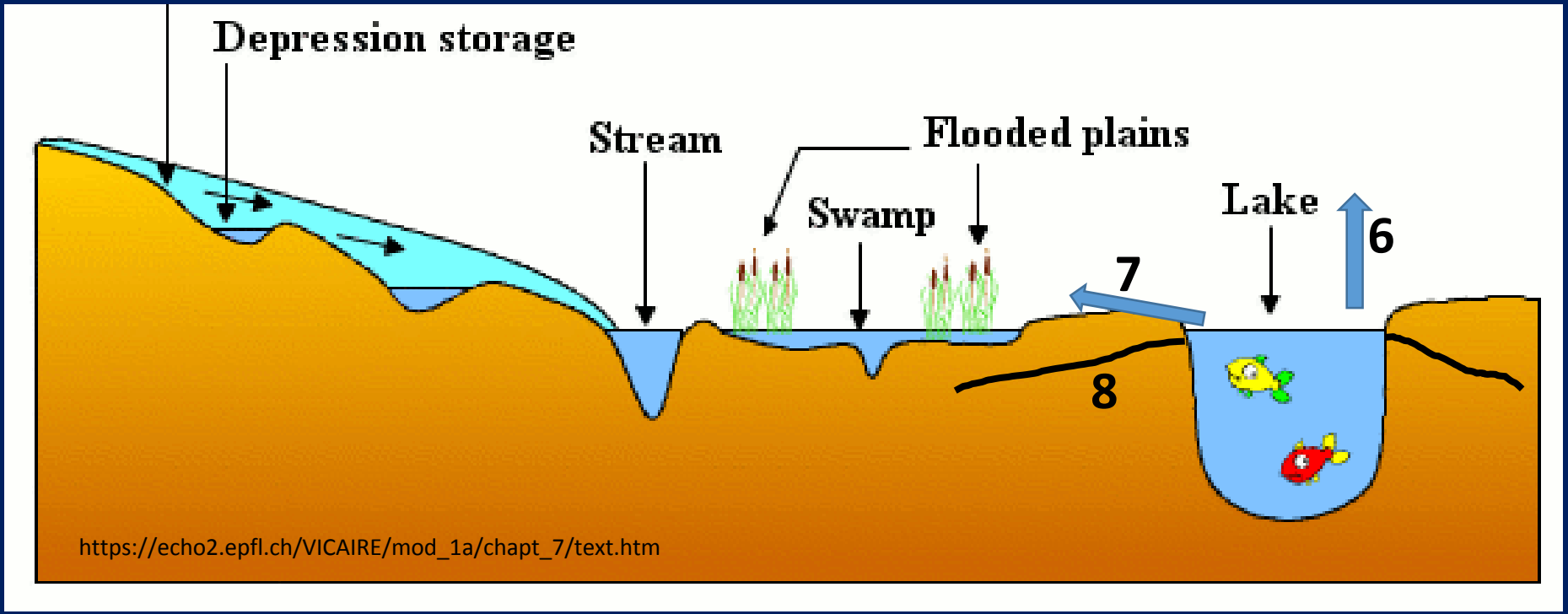
- Outflows remove from this volume (evaporation from the lake surface (6), outlet streams (7), ground-water seepage from the lake bottom (8))



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Hydrologic equation (law of mass conservation):

Inflow= outflow ± changes in storage

1+2+3+4+5=6+7+8 ± changes in storage

***** The most difficult factor to determine is the groundwater flux.**

Question: A lake with a surface area of 60 km^2 is recharged by a stream. During June, the average inflow and outflow rates of this stream were estimated as 0.62 m^3/s and 0.53 m^3/s, respectively. The precipitation and evaporation depths for June are 51 mm and 110 mm, respectively. The seepage of groundwater from the lake bottom is 3 cm. Calculate the change in lake volume and the water level during June.

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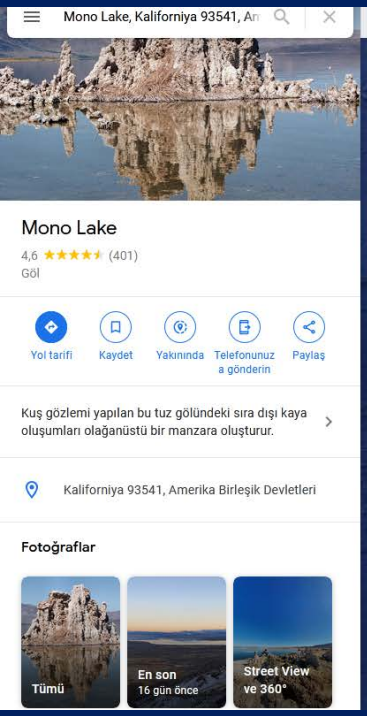
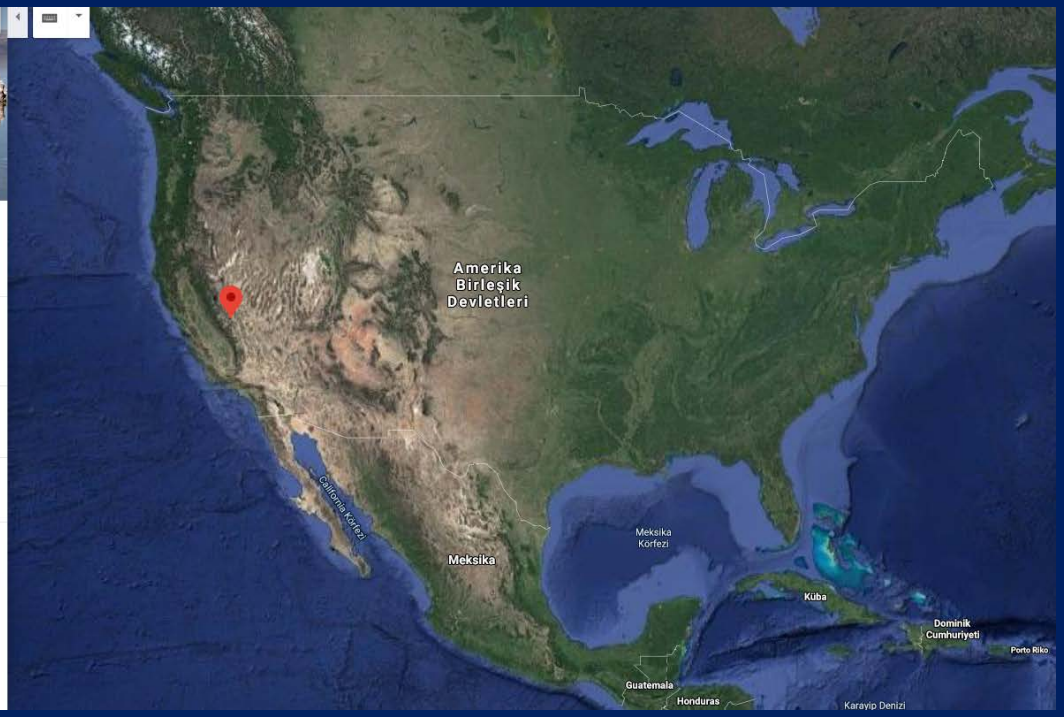
Mono Lake





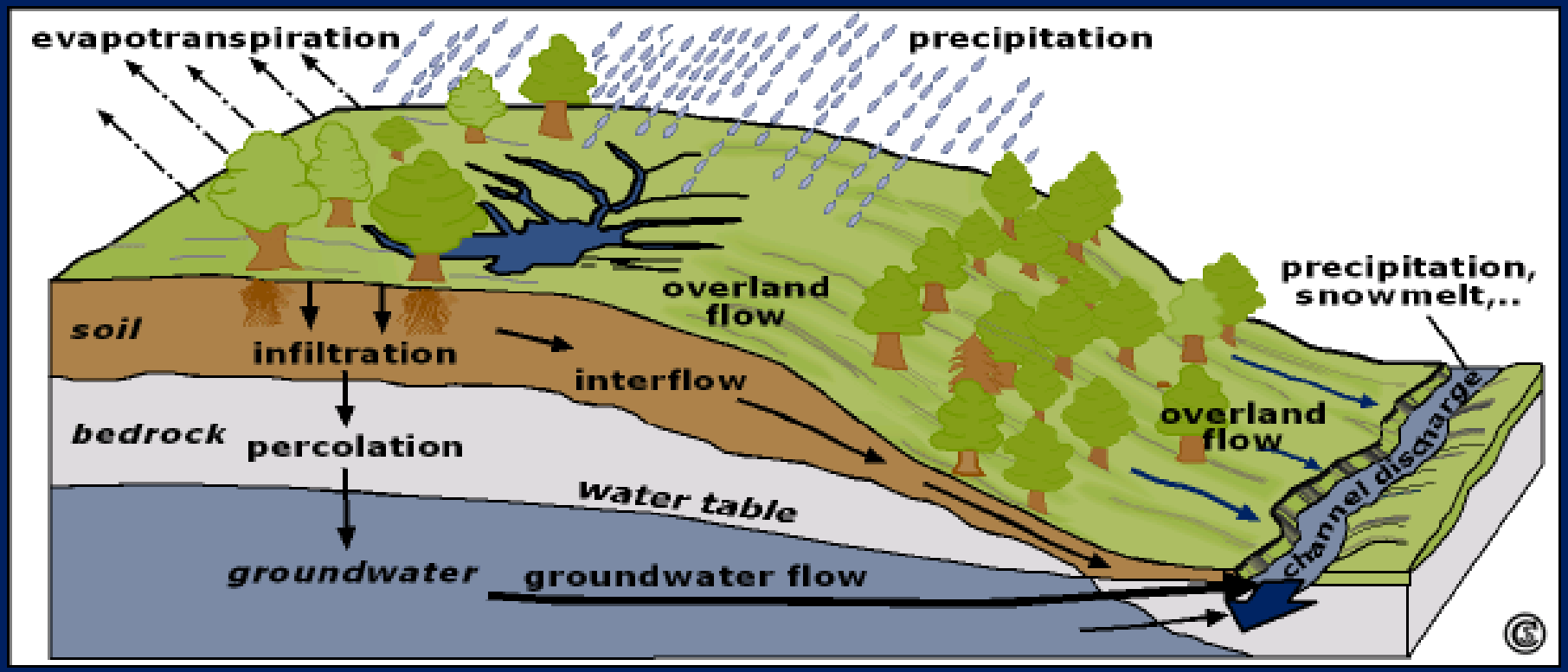
Drainage area 1800 km^2

Precipitation 200 mm

Evaporation 1100 mm

Stream inflows to the lake (measured) ($1.85*10^8$ m^3/year)

Groundwater inflow and ungauged streams $4.56*10^7$ m^3/year



The hydrological cycle
Image Credit: after data from Ahnert 1996, 175-177; Bradshaw and Weaver 1995, 45

Components of the hydrologic cycle

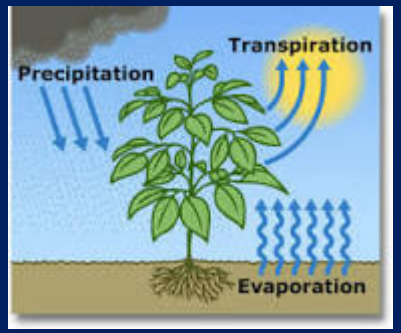
Condensation

Evaporation

Transpiration– Growing plants are continuously pumping water from the ground into the atmosphere through this process.

Evapotranspiration- under field conditions it is not possible to separate evaporation from transpiration. Therefore, the total water loss (through free-water evaporation, plant transpiration or soil moisture) from a basin

Precipitation



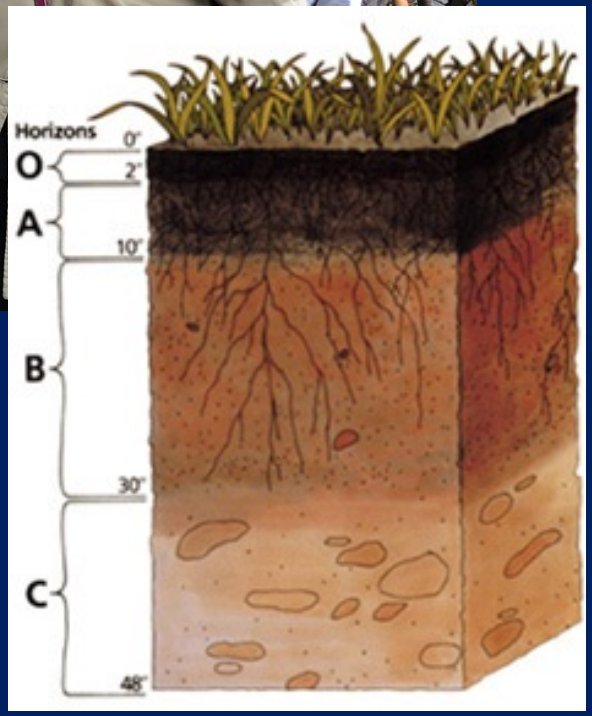
Transpiration can be measured by using a phytometer (a sealed container)

Evapotranspiration

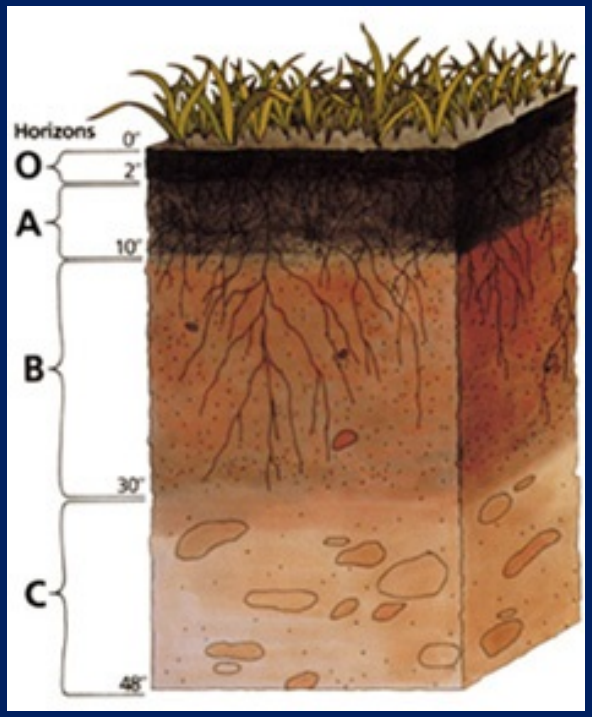
Free-water evaporation + transpiration by plants + soil moisture evaporation

Potential evapotranspiration (PET) would occur if there was always an adequate water supply available to a fully vegetated surface.

SOIL MOISTURE



https://www.soils4teachers.org/soil-horizons/



O (humus or organic): Mostly organic matter such as decomposing leaves. The O horizon is thin in some soils, thick in others, and not present at all in others.

A (topsoil): Mostly minerals from parent material with organic matter incorporated. A good material for plants and other organisms to live.

B (subsoil): Rich in minerals that leached (moved down) from the A or E horizons and accumulated here.

C (parent material): The deposit at Earth's surface from which the soil developed.

R (bedrock): A mass of rock such as granite, basalt, quartzite, limestone or sandstone that forms the parent material for some soils – if the bedrock is close enough to the surface to weather. This is not soil and is located under the C horizon.

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