

# **Hydrologic Cycle**

Prof. M.M.M. Najim

- Learning Outcome:
  - At the end of this section, the students will be able to explain the hydrological cycle, difference between green and blue water and differentiate different components in the cycle.

# 1. Cycle Component Concepts

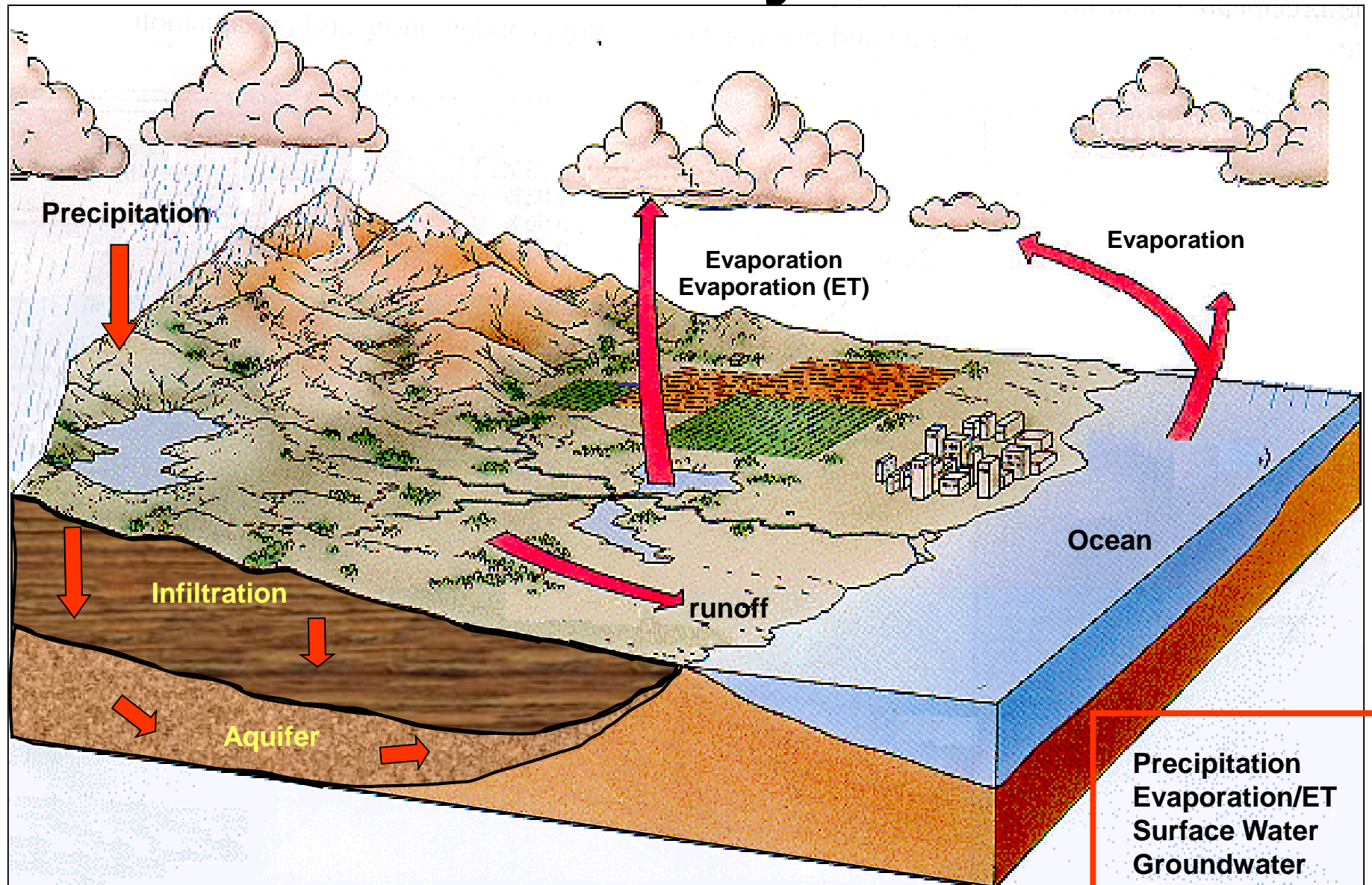
## Standard Concepts (Physical)

- Precipitation
- Evaporation/Evapotranspiration
- Surface Water
- Groundwater

## Ecosystem & Use Related (Basin/Watershed Perspective)

- Green water (Terrestrial ecosystems, Crops, Wetlands)
- Blue water (Throughflow, Consumptive use & return flow)

# Basic Cycle



# Basic Cycle

	Temperate climate		Semi-arid climate		Arid climate	
	%	mm	%	mm	%	mm
Total precipitation	100	500 - 1500	100	200 - 500	100	0 - 200
Real evapotranspiration	~ 33	150 - 500	~ 50	100 - 250	~ 70	0 - 140
<b>Groundwater recharge</b>	<b>~ 33</b>	165 - 495	<b>~ 20</b>	40 - 100	<b>~ 1</b>	0 - 2
Surface runoff	~ 33	165 - 495	~ 30	60 - 150	~ 29	0 - 58

***Approximate annual hydrological budget***

# 1. Cycle Component Concepts

## Standard Concepts (Physical)

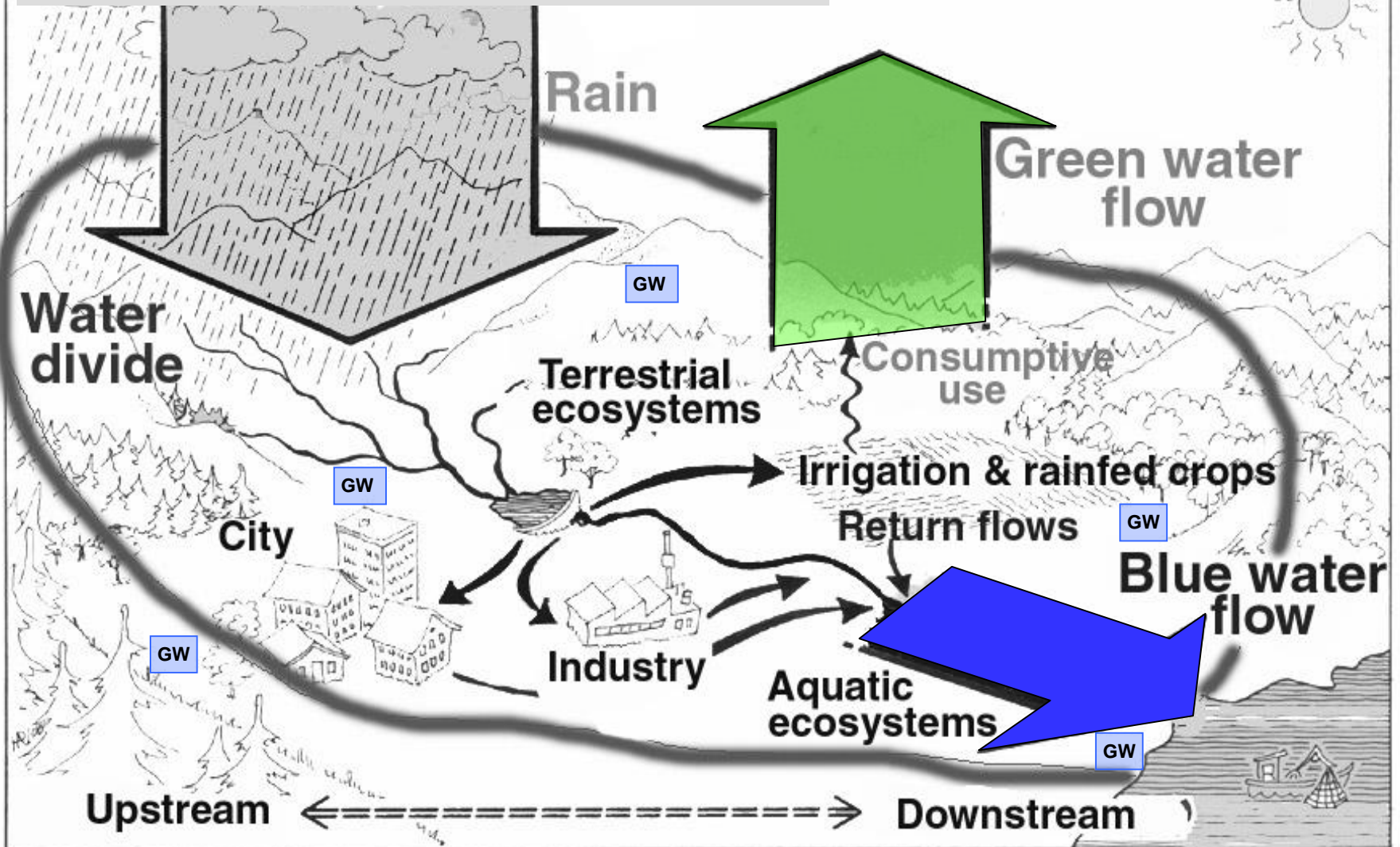
- Precipitation
- Evaporation/Evapotranspiration
- Surface Water
- Groundwater

## Ecosystem & Use Related (Basin/Watershed Perspective)

- **Green water** (Terrestrial ecosystems, Crops, Wetlands)
- **Blue water** (Throughflow, Consumptive use & return flow)

# Blue & Green Water - perspective

Precipitation – the basic water resource



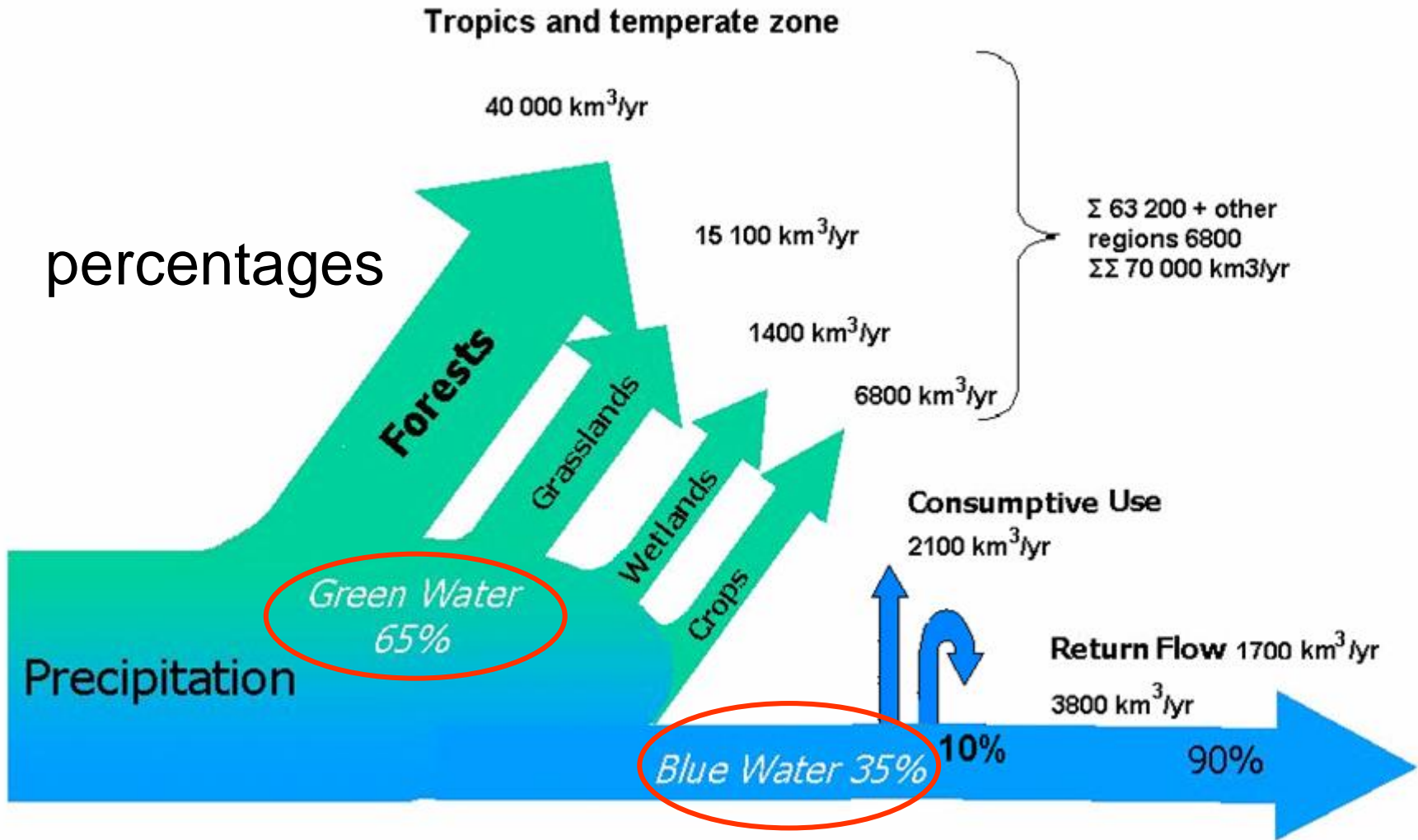
Adapted from: GWP (M. Falkenmark), 2003, Water Management and Ecosystems: Living with Change

# Blue and Green water

- $\frac{2}{3}$  of the precipitation is contributed to biomass production (Green water)
- $\frac{1}{3}$  moves to sea as liquid water (Blue water)



# Blue & Green Water – Pathways



Consumptive water use by terrestrial ecosystems as seen in a global perspective. (Falkenmark in SIWI Seminar 2001).

# Blue water

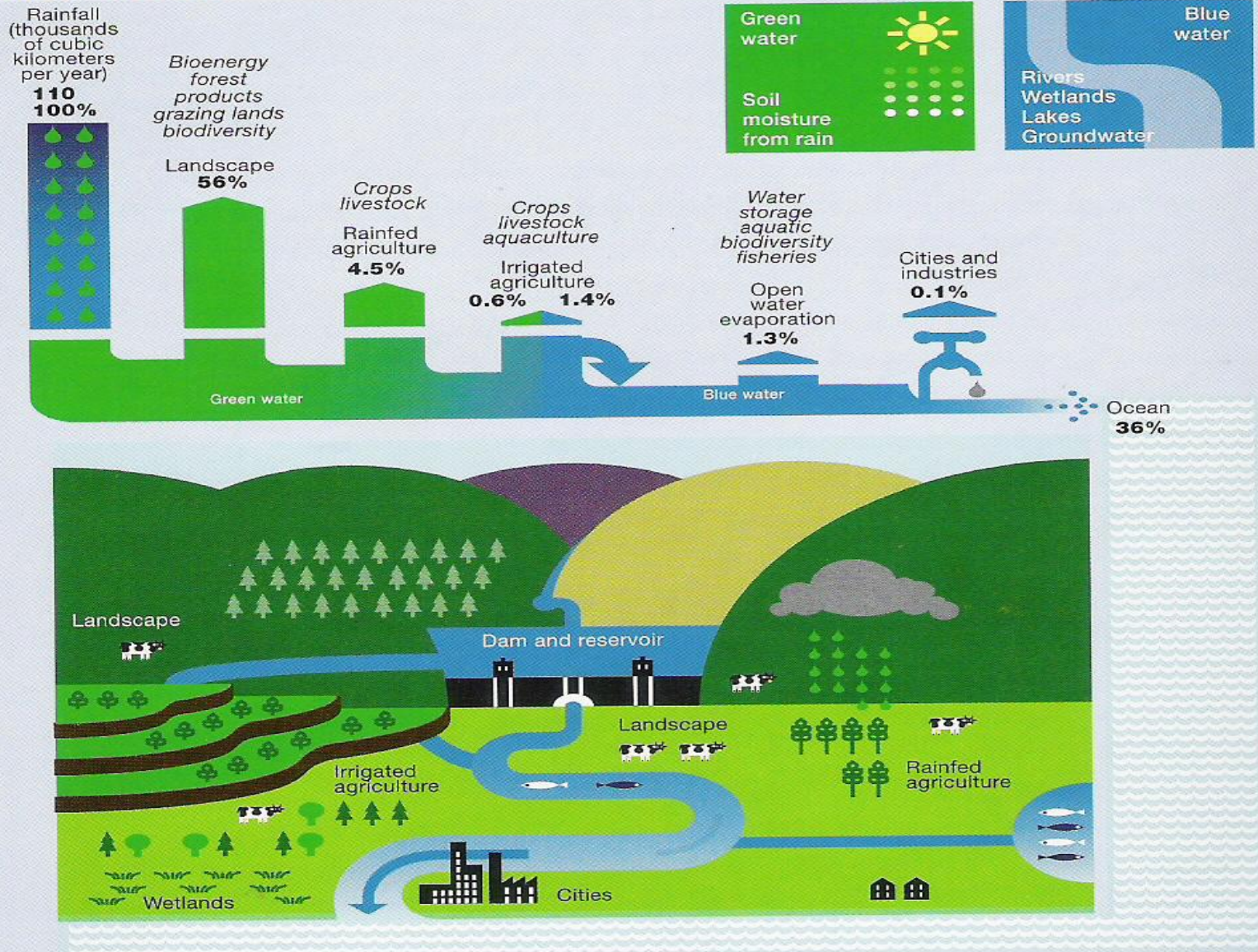
- **Visible liquid water flow moving above and below the ground (groundwater)**
- **Blue water can be recycled and re-used again**
- **Available for downstream use**

# Green water

- **Invisible flow of vapor to the atmosphere**
- **Has two components**
  - **Productive green water (transpiration)**
  - **Non-productive green water (evaporation of water from soil, interception etc)**
- **Green water can not be re-used and not available for downstream use**

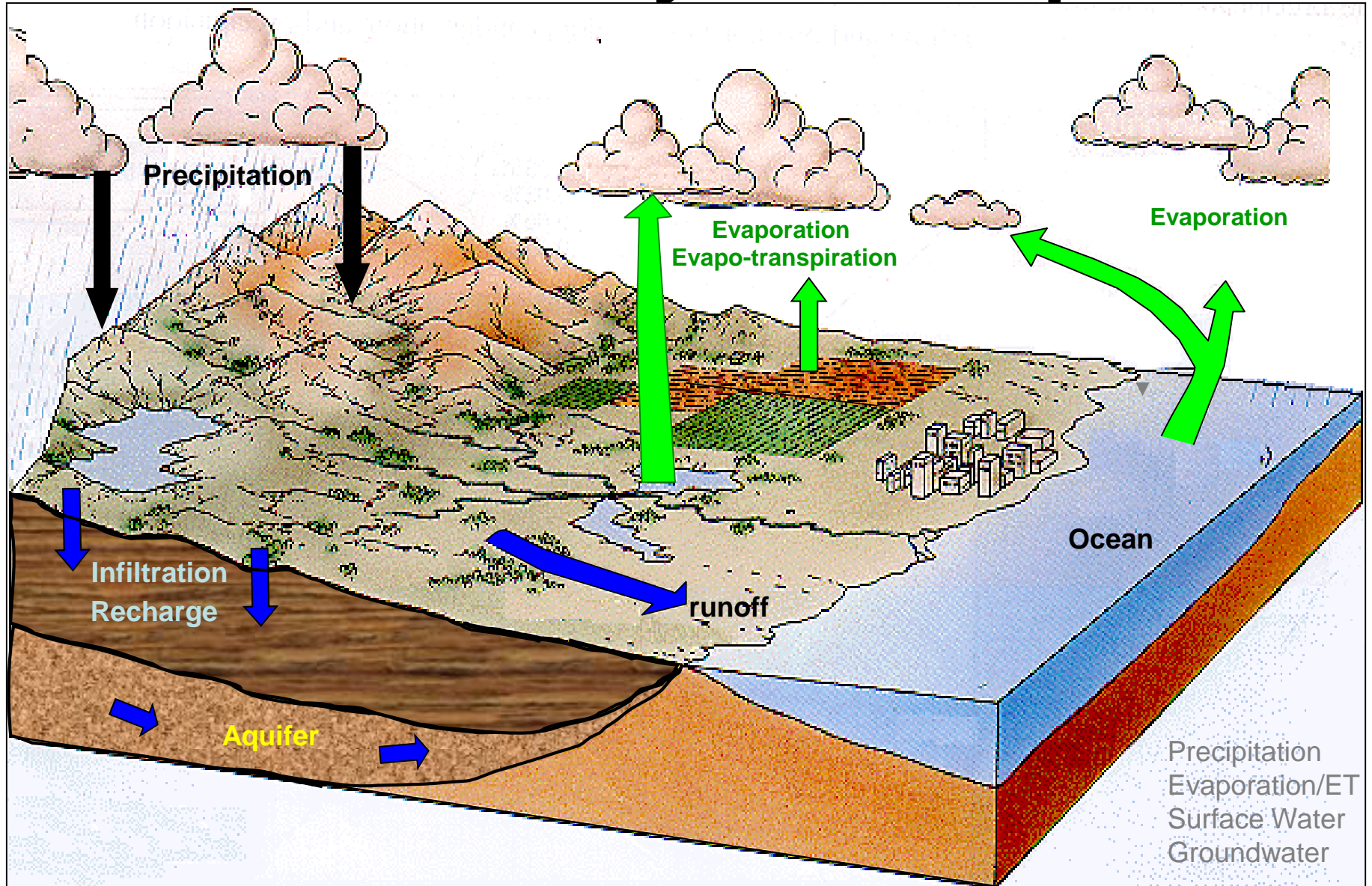


# Global water use



Source: Calculations for the Comprehensive Assessment of Water Management in Agriculture based on data from T. Oki and S. Kanae, 2006, "Global Hydrological Cycles and World Water Resources," *Science* 313 (5790): 1068-72; UNESCO-UN World Water Assessment Programme, 2006, *Water: A Shared Responsibility*, The United Nations World Water Development Report 2, New York, UNESCO and Berghahn Books.

# More Detailed Cycle Components

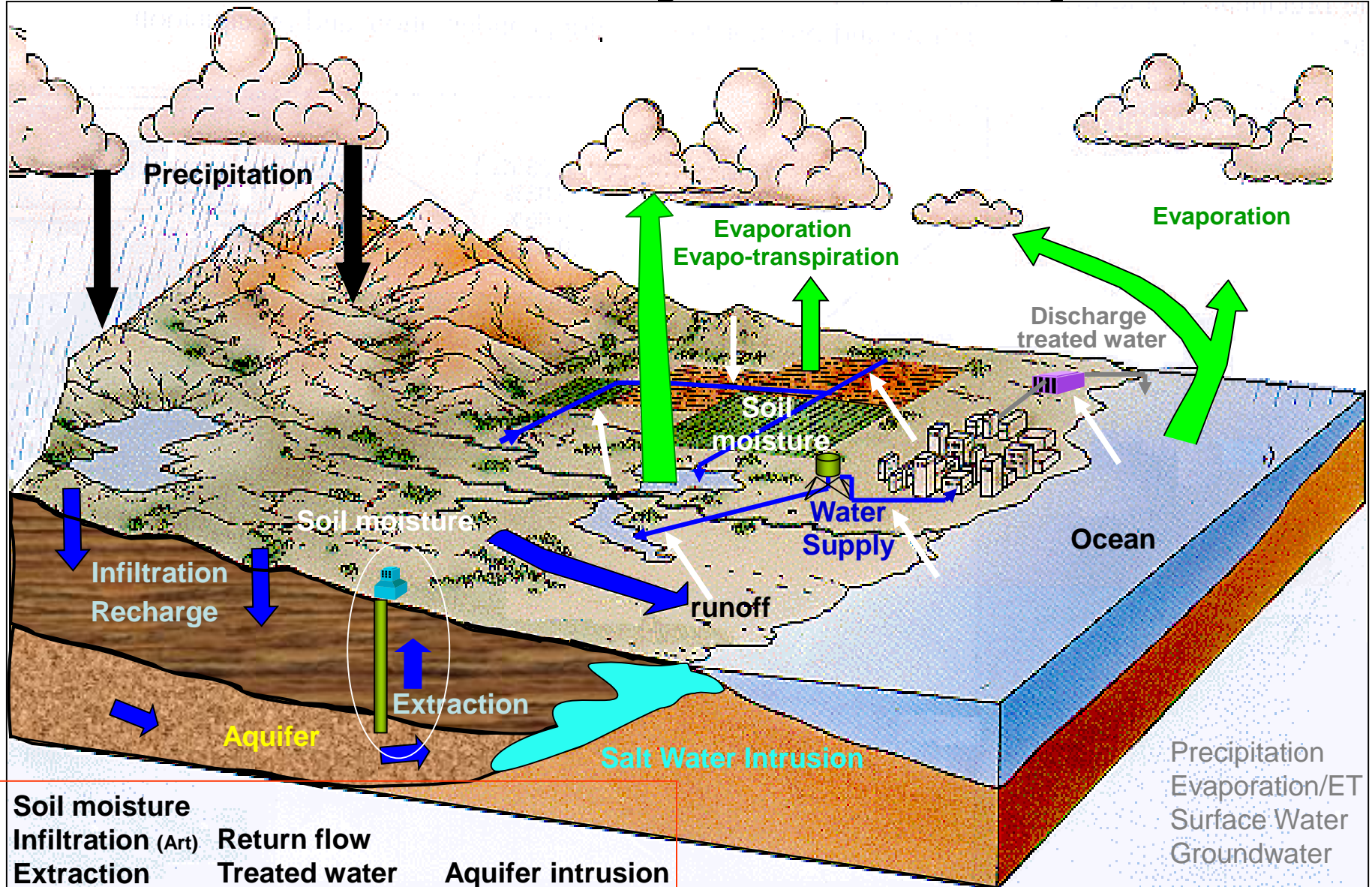


# WHAT ARE OTHER COMPONENTS IN THE CYCLE TODAY?

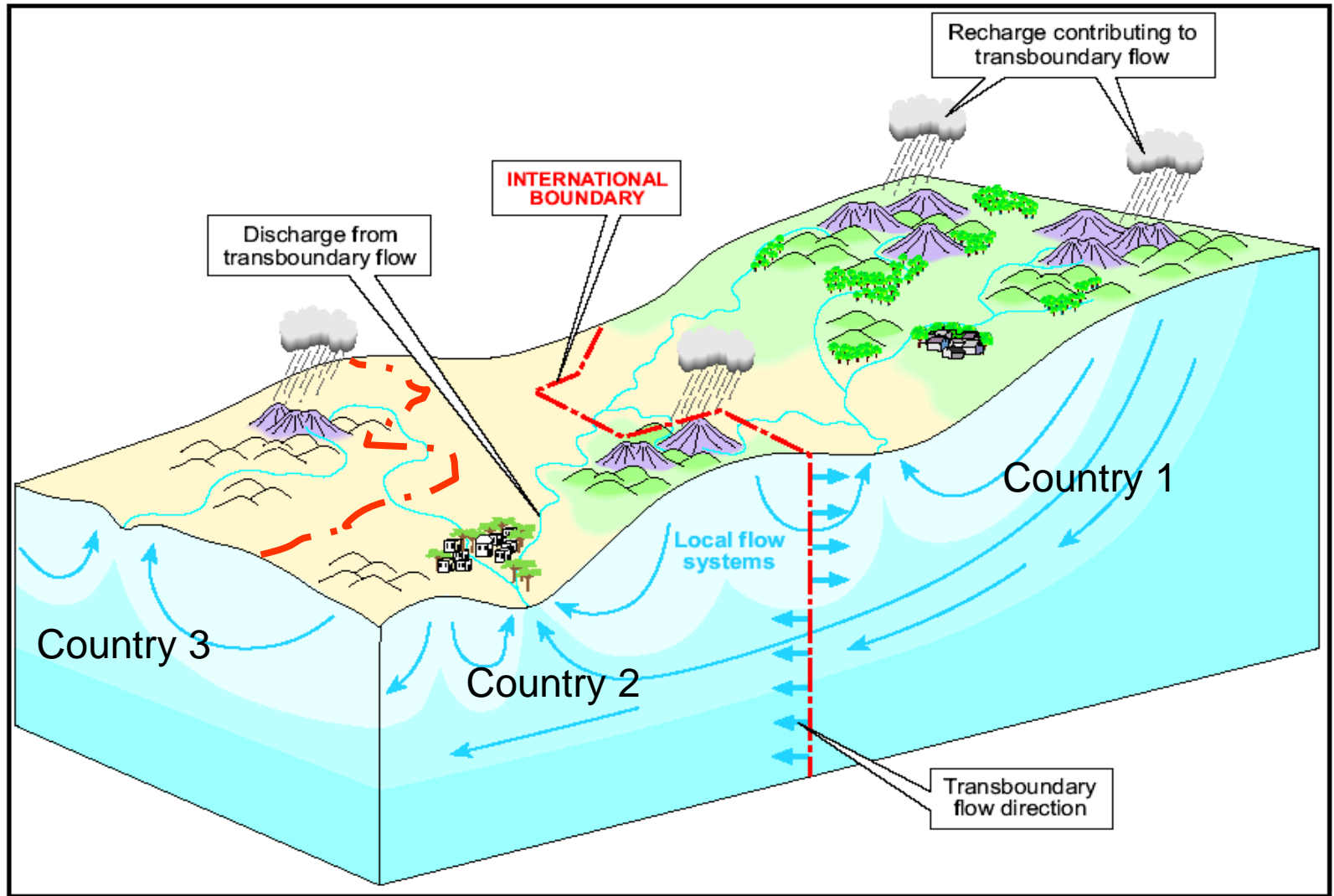
- Soil water
- Extraction schemes
- Artificial recharge
- Return flow
- Treated water - reuse
- Intrusion



# More Detailed Cycle Components

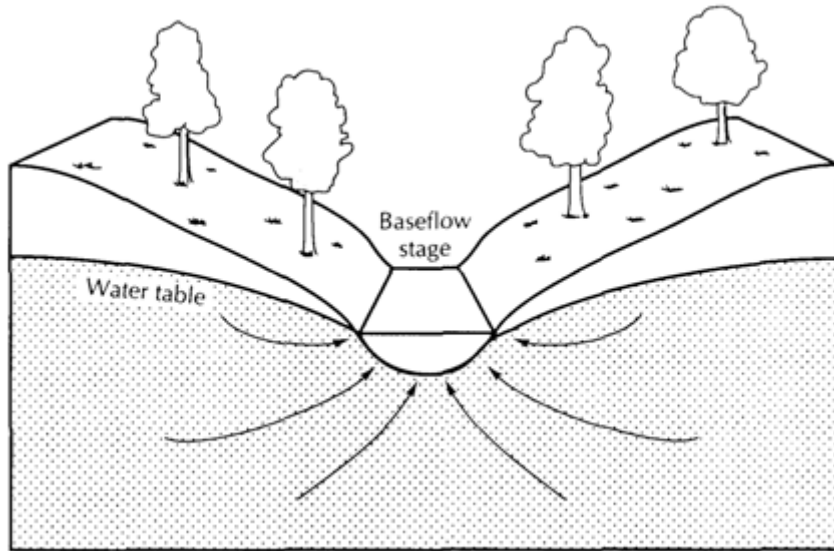


# 2. Watersheds – boundaries and

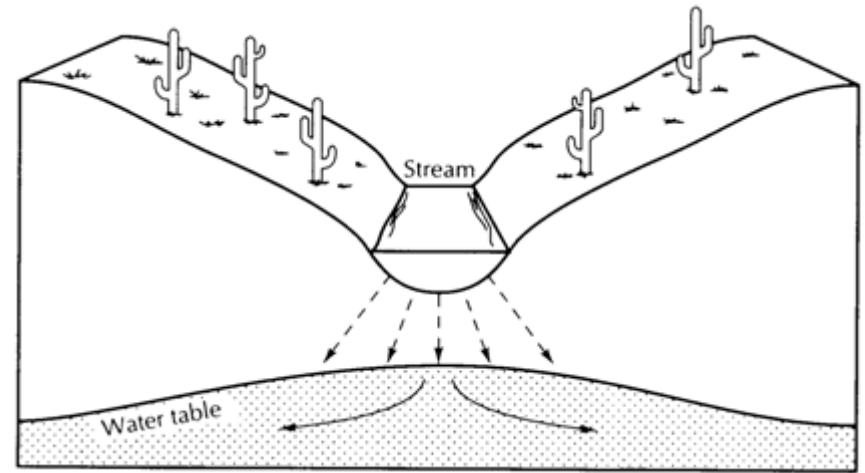




# SW/GW relations - Humid vs Arid Zones



A. Cross section of a gaining stream, which is typical of humid regions, where groundwater recharges streams



B. Cross section of a losing stream, which is typical of arid regions, where streams can recharge groundwater

Do not waste water even if you  
are at a running stream.