



# **Concepts of Groundwater Management**

# Groundwater Management

## ■ Objectives:

- Obtain maximum quantity of water.
- Meet quality requirements.
- Maintain the resource.

## ■ Consider:

- The growing demand of to exploit non-renewable resources.
- Political, social, and economic factors.
- Environmental impacts on groundwater resources.
- Technical issues (e.g. vertical wells vs. horizontal wells).

# Integrated Groundwater Management Solutions

- Development of an underdeveloped groundwater resource using different management strategies.
  - Water banking & Artificial recharge
  - Saline water intrusion control
  - Remediation of contaminated aquifers
- Desalination of seawater or brackish groundwater.
- Treating & reusing wastewater.
- Minimizing water supply net leakage.

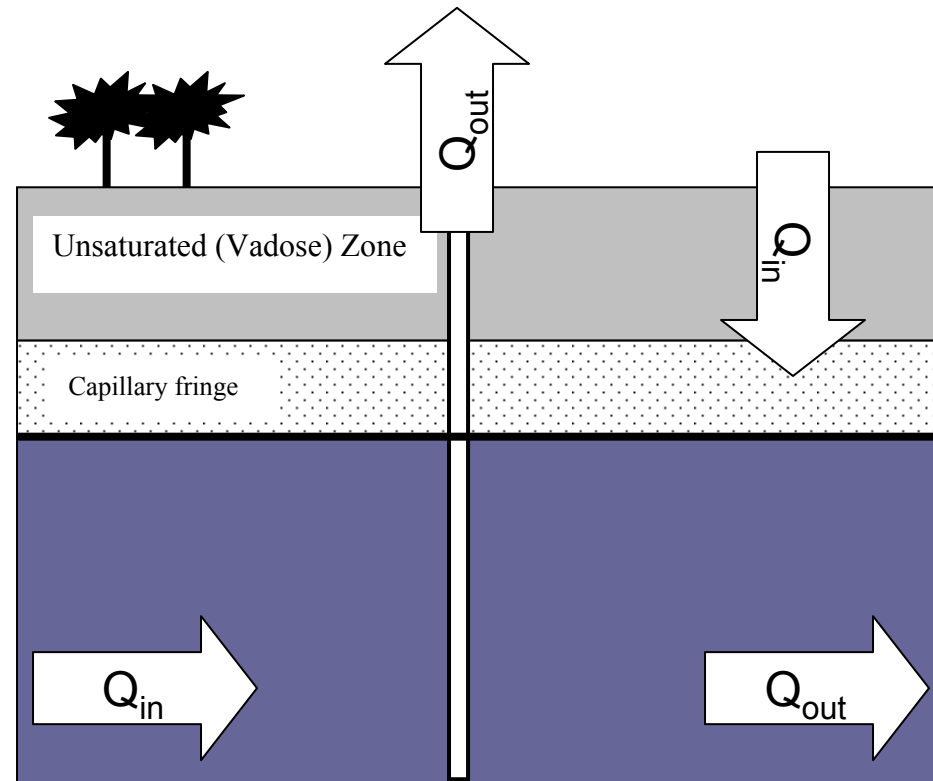
# Integrated Groundwater Management Solutions

- Development of more efficient water distribution and irrigation systems.
- Implementation of water conservation programs.
- Application of adequate charges.
- Importing water from other countries or regions.
- Using saline water for irrigation → R&D stage in UAE

# Water Budget Equation

An equation that describes the hydrologic equilibrium in a groundwater basin.

$$Q_{in} - Q_{out} = \Delta S$$



# Alternative Basin Yields

- Safe (perennial) yield: is the rate of groundwater extraction from a basin for consumptive use that can be maintained without negative effects like:
  - Impairing the native groundwater quality, or
  - Creating an undesirable effect such as environmental damage (e.g. sinkhole formation).

# Alternative Basin Yields

- Rules of thumb concerning safe yield:
  - Annual extraction of groundwater should not exceed the average annual recharge.
  - Extraction of groundwater should not lower the water table so permissible cost of pumping is exceeded. Examples of cost increase are:
    - Deepening wells
    - Using larger pumps
  - Pumping should not lead to a deterioration of water quality.
    - Seawater intrusion
    - Salty connate water upconing
    - Contaminated water migration enhancement

# Alternative Basin Yields

- Mining yield: is the rate of groundwater extraction that exceeds the average annual recharge.
  - Proper management of the groundwater basin is needed to keep the water for longer time
    - For example: investigating different management alternatives using groundwater flow and solute transport numerical models.
  - Water conservation programs.
    - Application of advanced irrigation water management systems
    - Utilization of the reclaimed water