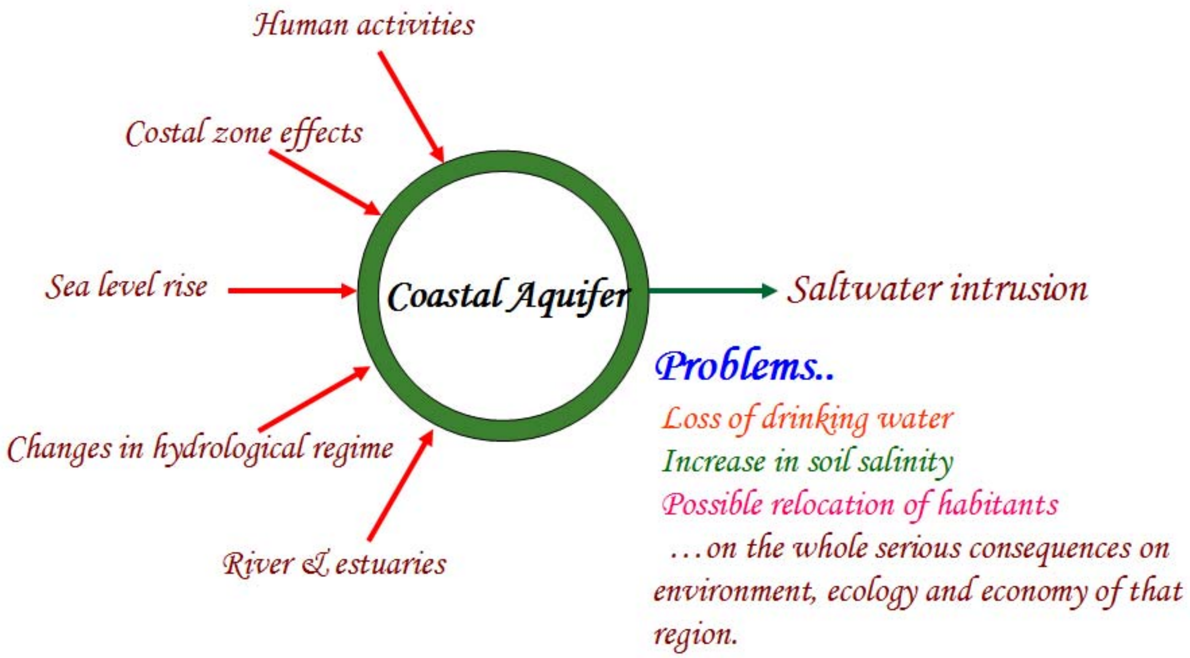
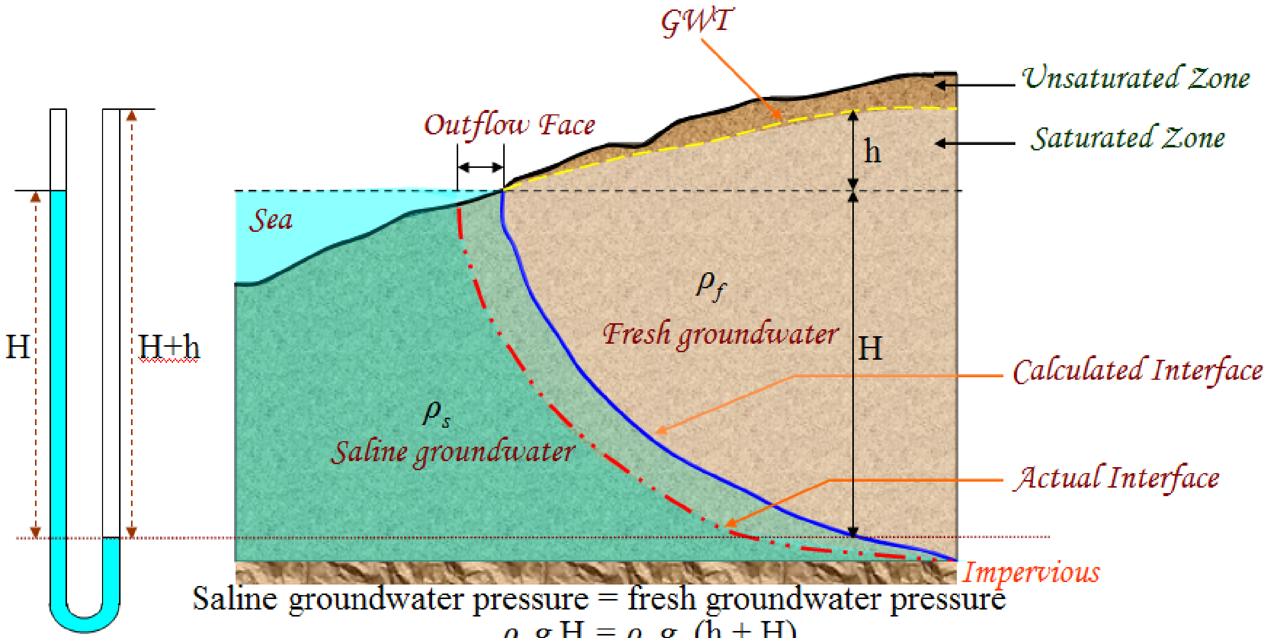
Q1: Write down the factors affecting the coastal aquifers.
Ans:



Q2: What are the countermeasures available for controlling the saltwater intrusion in coastal aquifers?
Ans:
The available countermeasures are listed below

- *Demand Management*
- *Non-potable Water Reuse*
- *Modified Pumping Rates*
- *Pumping Caps*
- *Well Relocation*
- *Conjunctive Use*
- *Aquifer Storage and Recovery*

Q3: Explain the Bodon Ghyben-Herzberg Principle using simple sketches.
Ans:



Saline groundwater pressure = fresh groundwater pressure

$$\rho_s g \, \mathrm{H} = \rho_f g \; (\mathrm{h} + \mathrm{H})$$

$\rho_s = 1025\ kg/m^3$
$\rho_f = 1000\ kg/m^3$

$$h = \frac{\rho_s - \rho_f}{\rho_f} H \quad \Rightarrow \quad \Delta \mathrm{h} = 40\ \Delta \mathrm{H}$$

Q4: Write down the classification of Hydraulic management strategies.
Ans:
Hydraulic Management

- Embedding Approach
  - Finite Difference or Finite Element based discretization of governing equation as constraints of management model
- Linked Simulation Optimization Approach
  - Externally linked simulation model as binding constraint
- Meta-Model Based Approach
  - Response Matrix Approach-Linear Model as constraints of management model
  - Soft Computing Models (Artificial Neural Network, Support Vector Machine) as constraints of management model

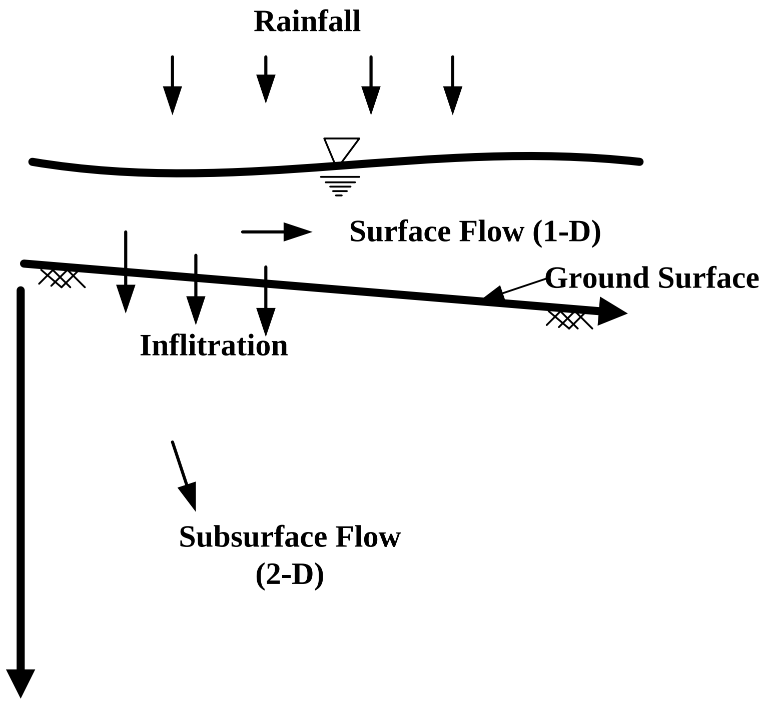
Q5: Define Monitoring Network Design. Write down the types of long-term monitoring network design approaches.
Ans: Monitoring Network Design is the method for selection of sampling schedule under budgetary limitation.

Types of long-term monitoring network design approaches

- Ambient monitoring

  - ✓ Regional, annual monitoring for water safety.
- Detection monitoring
  - ✓ Watch a dangerous spot
- Compliance monitoring
  - ✓ Evaluate the progress of a management policy
- Research monitoring
  - ✓ Monitoring for a specific research purpose

Q6: Write down the governing equations for combined surface-subsurface modeling.



Governing equation for 1-D Surface Flow

$$\frac{\partial \mathbf{U}}{\partial t} + \frac{\partial \mathbf{F}}{\partial x} = \mathbf{S}$$

with

$$\mathbf{U} = \begin{Bmatrix} h \\ q \end{Bmatrix}, \mathbf{F} = \begin{Bmatrix} q \\ \frac{q^2}{h} + \frac{gh^2}{2} \end{Bmatrix}, \mathbf{S} = \begin{Bmatrix} R - I \\ gh(S_0 - S_f) \end{Bmatrix}$$

Where,

$h =$ flow depth,

$q =$ discharge per unit width,

$g =$ acceleration due to gravity,

$R =$ volumetric rainfall per unit surface area,

$I =$ volumetric infiltration per unit area,

$S_0 =$ bottom slope in the direction of flow,

$S_f =$ friction slope.

Governing equation for 2-D subsurface flow (Richards equation):

$$\frac{\partial\theta}{\partial t} = \frac{\partial}{\partial x}\left[K(\psi)\frac{\partial\psi}{\partial x}\right] + \frac{\partial}{\partial z}\left[K(\psi)\left(\frac{\partial\psi}{\partial z} - 1\right)\right]$$

Where

$\theta =$ volumetric moisture content,

$\psi =$ pressure head,

$K(\psi) =$ unsaturated hydraulic conductivity

Reference:

Singh, V. and Bhallamudi, S.M. (1998) “Conjunctive surface-subsurface modeling of overland flow” Advances in Water Resources, Vol. 21, No. 7. pp. 567-579.