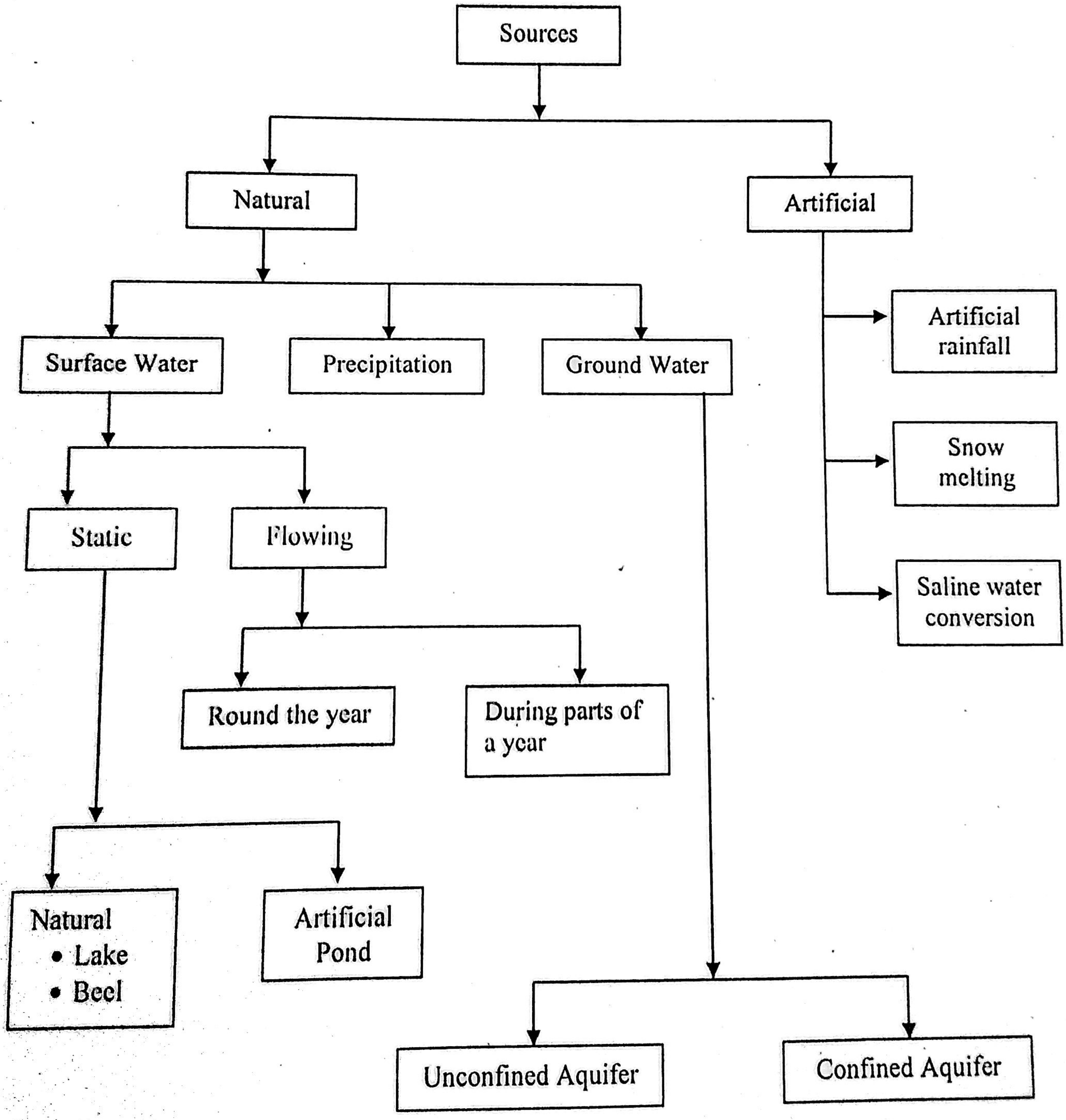
Md. Arifur Rahman
Assistant Professor
Dept. of Water Resources Engineering
BUET. Dhaka-1000

SOURCES & QUALITY OF IRRIGATION WATER

Sources of Irrigation Water



Considerations for using surface water as a source:

1. Lowest available water
2. Crop water requirement
   - Water needed $(S_1) = R_1 - x_1$

     Where, R_1 = Crop water requirement

     x_1 = Effective rainfall
3. Water quality (salinity & toxicity)
4. Water right – Other users
   - Domestic water supply
   - Navigation
   - Fish culture
   - Industry
   - River morphology
5. Control structure
   - Initial cost
   - Operating & maintenance cost

Consideration for Ground Water:

- Crop water requirement
- Availability of surface water source
- Position of ground water table
- Water quality
- Ground water recharge
- Environmental impact

Conjunctive use of Surface Water & Ground Water

- Use of both Surface Water (SW) & Ground Water (GW)
- Such a way that Ground Water recharges & draft balances with each other.
- Factors governing the percentage of sharing SW & GW
  - ✓ Natural recharge
  - ✓ Artificial recharge
  - ✓ Aquifer characteristics
  - ✓ Availability of surface water
  - ✓ Availability of fuel
  - ✓ Operation & maintenance cost for pumps
  - ✓ Economic consideration

Storage of Surface Water or rainfall:

- Availability of space
- Series of droughts can be easily overcome by GW storage
- Water table control easier
- Ground water is recharged

Ans (2)

Quality of irrigation water

Good quality water is essential for high production

- Physical : Color, odor, silt
- Chemical : Salt, alkaline
- Biological : Coliform

Ans (3)

Water quality related problems:

(1) Salinity:

- Salts in soil or water reduce water availability to the crop to such an extent that yield is affected.
- Salts accumulate in the root zone and the crop cannot extract sufficient water from the salty soil solution.
- The plants symptoms are
  - Wilting or darker, bluish-green color & sometimes thicker leaves.
- Leaching can remove the accumulated salts from the root zone.

(2) Water infiltration rate:

- Relatively high sodium or low calcium content of soil or water reduce the rate of infiltration to such an extent that sufficient water cannot be infiltrated to the crop adequately from one irrigation to the neat.
- This occurs within few centimeters of the soil surface and linked to the structural stability.
- When a high sodium surface is developed it weakens the soil structure. The soil particles become finer and clog the soil pores.

(3) Toxicity:

- Certain ions (sodium, chloride or boron) from soil or water accumulate in a sensitive crop to concentration high enough to cause crop damage and reduce yield.
- Toxic ions absorbed with water in significant amounts, and transported to the leaves and they accumulate during transportation.

(4) Miscellaneous:

- Excessive nutrients reduce yield or quality.
- Unsightly deposits fruit or foliage reduces marketability.
- Excessive corrosion of equipment increases maintenance and repairs.
- Sediments tend to fill the cannels, lands etc.
- These include high nitrogen, prudence of silt, bicarbonate, iron.

Various impurities in irrigation water

Every water may not be suitable for plant life. The quality of suitable irrigation water is very much influenced by the constituents of the soil which is to be irrigated. The various types of impurities, which make the water unfit for irrigation, are classified as:

(1) Sediment concentration in water.
(2) Total concentration of soluble salts in water.
(3) Concentration of sodium ions to other cations.
(4) Concentration of potentially toxic elements present in water.
(5) Bicarbonate concentration as related to concentration of Ca plus Mg
(6) Bacterial concentration

The effects of these impurities are discussed below:

(1) Sediment concentration of soluble salts

- ✓ The effect of sediment present in the irrigation water depends upon the type of irrigated land.
- ✓ When fine sediment from water deposited on sand soils, the fertility is improved.
- ✓ The sediment has been derived from the eroded areas; it may reduce the fertility or decrease the soil permeability.
- ✓ Sediment water increases the siltation and maintenance costs.

In general, ground water or surface water from reservoirs etc. does not have sufficient sediment to cause any serious problems in irrigation.

(2) Total concentration of soluble salts:

Salts of calcium, magnesium, sodium and potassium, present in the irrigation water may prove injurious to plants. When present in excessive quantities, they reduce the osmotic activities of the plants, and may present adequate aeration, causing injuries to plant growth. The injurious effects of salts on the plant growth depend upon the concentration of salts left in the soil.

The effects of salts on plant growth depend largely upon the total amount of salts present in the soil solution. The salinity concentration of the soil solution (C_s) after the consumptive water (C_u) has been extracted from the soil, is given by

$$C_s = \frac{CQ}{Q - (C_u - P_{eff})} \qquad (2.1)$$

Where,

Q = Quantity of water applied

C_u = Consumptive use of water, i.e, the total amount of water used by the plant for its growth.

P_{eff} = Useful rainfall

$C_u - P_{eff}$ = Used up irrigation water

C = Concentration of salt in irrigation water

CQ = Total salt applied to soil with Q amount of irrigation water

Total salt concentration in water is expressed as:

(a) Parts per million parts of water (ppm)
(b) Milligram per liter of water (mg/l)
(c) Electrical Conductivity of water (EC)

(a) Parts per million (ppm)

The result of a chemical analysis of water are usually report in parts per million of the various substances present in the sample. One part per million (ppm) means one part in a million parts. As commonly measured and used, parts per million in numerically equivalent to milligrams per liter.

Amount in excess of 700 ppm	Harmful to some plants
More than 2000 ppm	Injuries to all crops

(b) Milligram per liter (mg/l)

(c) Electrical Conductivity (EC)

It is the reciprocal of the Electrical resistivity. Quantitively the electrical resistivity is the resistance, in ohms, of a conductor, metallic or electrolytis, which is 1 cm long and has a cross-sectional area of 1 cm^2 at 25°C. The terms "*Electrical Conductivity*" and specific electrical conductance have identical meanings. Standard method of evaluating total salts present in irrigation water.

Electrical conductivity is expressed as the reciprocal of ohm/cm or mhos/cm.
milimhos per cm (mmhos/cm) or deci-siemens per meter (ds/m)

For convenience in units, millimhos/cm (10^{-3} mhos/cm) or micromhos/cm (10^{-6} mhos/cm) are used.

Electrical conductivity (EC) is expressed in **micro mhos per centimeters (μS/cm)**.

SL No.	Electrical Conductivity (micro mhos/cm at 25° C)	Type of water
1	Up to 250	Low Conductivity Water (C1)
2	250 to 750	Medium Conductivity Water (C2)
3	750 to 2250	High Conductivity Water (C3)
4	Above 2250	Very High Conductivity Water (C4)

The suitability of these four types of waters for irrigation supplies are discussed in Table below.

SL	Type of water	Use in Irrigation
1	Low salinity water (C1). Conductivity between 100 to 250 micro mhos/cm at 25° C	Can be used for irrigation for almost all crops and for almost all kinds of soils. Very little salinity may develop, which may require slight leaching, but it is permissible under normal irrigation practices except in soils of extremely low permeabilities
2	Medium salinity water (C2). Conductivity between 250 to 750 micro mhos/cm at 25° C	Can be used, if a moderate amount of leaching occurs. Normal salt-tolerant plants can be grown without much salinity control
3	High salinity water (C3). Conductivity between 750 to 2250 micro mhos/cm at 25° C	Cannot be used on soils with restricted drainage. Special precautions and measures are undertaken for salinity control and only high-salt tolerant plants can be grown
4	Very high salinity water (C4). Conductivity more than 2250 micro mhos/cm at 25° C	Generally not suitable for irrigation

(3) Relative proportion of sodium ions to other cations in irrigation water

Most of the soils contain Ca^{++} and Mg^{++} ions and small quantities of Na^{+}. The percentage of the Na^{+} is generally less than 5% of the total exchangeable cations. If this percentage increases to about 10% to more, the aggregation of soil grains breaks down. The soil becomes less permeable and of poorer tilth. It starts crusting when dry and its pH increases towards that of an alkaline soil. High sodium soils are, therefore, plastic, sticky when wet, and are prone to form clods, and they crust on drying.

The methods for determining relative proportion of sodium ions to other cations are:

(a) Sodium absorption ratio (SAR)
(b) Exchangeable sodium percentage (ESP)
(c) Sodium percentage (SP)

(a) Sodium Absorption Ratio (SAR):

A ratio for soil extracts and irrigation water used to express the relative activity of sodium ions in exchange reaction with soil in which the ionic concentration are expressed in milli-equivalents per liter.

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

[epm is obtained by dividing the concentration of salt in mg/l or ppm by its combining weight (i.e. Atomic wt + Valence)]

SL No.	SAR	Type of water
1	0 to 10	Low Sodium Water (S1)
2	10 to 18	Medium Sodium Water (S2)
3	18 to 26	High Sodium Water (S3)
4	More than 26	Very High Sodium Water (S4)

The SAR value can be reduced by adding gypsum ($CaSO_4$) to the water or to the soil.

SL	Type of water	Use in irrigation
1	Low Sodium Water (S1). SAR value lying between 0 to 10	Can be used for irrigation on almost all soils and for almost all crops except those which are highly sensitive to sodium, such as stone-fruit trees and avocados, etc.
2	Medium Sodium Water (S2). SAR value lying between 10 to 18	Appreciably hazardous in fine textured soils, which may require gypsum, etc; but may be used on course textured or organic soils with good permeability.
3	High Sodium Water (S3). SAR value lying between 18 to 26	May prove harmful on almost all the soils, and do require good drainage, high leaching, gypsum addition etc. for proper irrigation.
4	Very High Sodium Water (S4). SAR value above 26	Generally not suitable for irrigation

(b) **Exchangeable Sodium Percentage (ESP):**

It is the degree of saturation of the soil exchange complex with sodium and may be calculated by the following formula:

$$ESP = \frac{\text{Exchangeable Sodium (milli-equivalent/100 gm soil)}}{\text{Cation exchange capacity (milli-equivalent/100 gm soil)}} \times 100$$

Where, ionic exchange is in milliequivalent per 100 gm soil

(c) **Sodium Percentage (SP):**

The moisture percentage of a saturated soil paste expressed on dry wt. basis.

$$SP = \frac{Na^+}{Na^+ + Ca^{++} + Mg^{++} + K^+} \times 100$$

Where, ionic concentration is in (me/l)

(4) **Concentration of potentially toxic elements**

- A large number of elements such as Boron, Selenium etc. may be toxic to plants.
- Traces of Boron are essential to plant growth, but its concentrations above 0.3 ppm may prove toxic to certain plants.
- The concentration above 0.5 ppm is dangerous to nuts, citrus fruits and deciduous fruits.
- Cotton, Cereals and certain truck crops are moderately tolerant to Boron, while Dates, Beets, Asparagus etc. are quite tolerant.
- Even for the most tolerant crops, the Boron concentration should not exceed 4 ppm.
- Boron is generally present in various soaps.
- The waste water containing soap, etc. should, therefore, be used with great care in irrigation.
- Selenium even in low concentration, toxic, and must be avoided.

Boron concentrations of as little as 2 to 4 milligrams per liter may be harmful to crops. Some crops are more tolerant to boron than others. Table below shows that beets have a relatively high tolerance whereas pear, apple, and peach trees have a low tolerance.

Table: Relative tolerance of some crop to Boron

High	Medium	Low
Sugar beet	Sunflower	Pecan
Garden beet	Cotton	Black walnut
Alfalfa	Radish	Nary beam
Gladiolus	Field peas	Pear
Onion	Barley	Apple
Turnip	Wheat	Peach
Cabbage	Corn	
Lettuce	Milo	
Carrot	Oats	
	Pumpkin	
	Sweet potatoes	

(5) **Bicarbonate concentration as related to concentration of calcium plus magnesium**

High concentration of bi-carbonate ions may result in precipitation of calcium and magnesium bi-carbonates from the soil-solution, increasing the relative proportion of sodium ions and causing sodium hazards.

Residual Sodium Carbonate (RSC)

- Indicate the residual carbonates in excess of the lime elements.

$$RSC = (CO_3^- + HCO_3^-) - (Ca^{++} + Mg^{++})$$

Where, ionic concentrations are in (me/l)

(6) Bacterial contamination

Bacterial contamination of irrigation water is not a serious problem, unless the crops irrigated with highly contaminated water directly eaten, without being cooked. Cash crops like cotton, nursery stock, etc. which are processed after harvesting, can, therefore, use contaminated waste waters, without any trouble.

Table: Quality Rating of Ground Water

Water quality		EC (dS/m)	SAR $(mmole/l)^{1/2}$	RSC (me/l)
Good		< 2	< 10	< 2.5
Saline				
(i)	Marginally Saline	2 ~ 4	< 10	< 2.5
(ii)	Saline	4	< 10	< 2.5
(iii)	High SAR saline	4	> 10	< 2.5
Alkaline Water				
(i)	Marginally Alkali	< 4	< 10	2.5 – 4.0
(ii)	Alkali	< 4	< 10	4.0
(iii)	Highly Alkali	Variable	10	4.0

1. Good Water, EC < 2, and SAR < 10
2. Saline Water, EC = 2, and SAR < 10
3. High SAR saline water, EC = 4, and SAR > 10
4. Alkali water, EC variable, SAR variable, RSC > 2.5.

Precautions in saline water use:

Use of saline water in irrigation creates many problems. When situation demands its use, the following points should be borne in mind:

- Water should be applied in excess amount than required to meet the water deficit in the crop root zone to leach down the surplus salts.
- Excess salt should be leached down by abundant irrigation particularly before sowing.
- Soil should be lighter in texture, porous and permeable so that the leaching operation is easy. Clay soils do not allow easy leaching and are likely to become saline at a faster rate.
- Irrigation should be frequently applied to avoid shortage of available water to plants and a sudden variation in salt concentration of the salt solution.
- Evaporation should be reduced as far as economically feasible. If it remains unchecked, it would recharge the root zone soil with salts from below.
- Water table should be lowered to a depth from which there is no reaching of water and salts in the root zone. Low water table encourage a good drainage of the soil.
- Land should be properly graded and leveled as greater salt accumulation occurs in higher part of an uneven field.
- Drainage of the field must be properly maintained to prevent water logging.
- Soil should be maintained in good physical condition with addition of organic matter and by proper tillage.
- Liming of soil may be undertaken if sodium content of irrigation water is likely to cause injury to soil or crops.
- All corrective measures should be undertaken to keep sodium ion concentration in soil as low as possible. Sodium ion concentration should not exceed 12 percent of the total cation exchange capacity or the soil exchange complex.
- Check method of irrigation should preferably be adopted in irrigation should be totally avoided.
- A satisfactory and balanced schedule of fertilizer application to crops.
- Salt tolerant crops should be grown.

The foregoing measures would make the use of saline water much safer for irrigation and ensure better crop growth and yield.

Guidelines for using poor quality water:

Special consideration:

1) Use of gypsum when saline water (having SAR > 20 and/or Mg/Ca ratio > 3 and rich in silica) induce water stagnation during rainy season and crops grown are sensitive to it.
2) Leaving the field fallow during the rainy season is helpful when SAR > 20 and water of higher salinity and used in lower rainfall areas.
3) Additional phosphorus fertilization is beneficial especially when Cl/SO_4 ratio in water is greater than 20.
4) Canal water preferably be used growth stage including pre-sowing irrigation for conjunctive use with saline water.
5) If saline water is to be used for seedling of crops 20% extra seed rate and quick post-sowing irrigation (within 2 – 3 days) will ensure better germination
6) When $EC_{iw} < EC_e$ (0 – 45 cm soil at harvest of rab crops) saline water irrigation just before the onset of monsoon will lower soil salinity and will raise the antecedent soil moisture for greater salt removal by rains.
7) Use organic materials in saline environment enhance yields.
8) Accumulation of B, NO_3, Fe, Si, F, Se and heavy metals beyond critical limits proves toxic. Expert advice prior to the use of such water may be obtained.
9) For soils having (i) shallow water table (within 1.5 m in kharif season) and (ii) hard sub-soil layers, the next lower EC_{iw}/alternative mode of irrigation (canal/saline) is applicable.

Leaching Requirement:

Leaching is the process of dissolving the soluble salts and removing the same from the desired soil layers by the downward movement of water.

- To leach out the excess salts, water is applied in a quantity more than the normal requirements of the crops to avoid accumulation of salts.
- It is done by ponding water on the soil surface by bunds or borders and allowing a downward monument of water through the soil column
- The efficiency of leaching depends on the amount of water applied, the uniformity of water distribution and the adequacy of drainage in the field.
- Fertilizers should be applied only after leaching is completed.

It may be expressed as,

$$LR = D_d/D_{iw} = EC_{iw}/EC_d \text{ ------------------------------- } (1)$$

Where,

LR = Leaching requirement, expressed as a ratio or as percent
EC_{iw} = Electrical conductivity of irrigation water, mS/cm
EC_d = Electrical conductivity of drainage water, mS/cm
D_d = Depth of drainage water, cm

The leaching requirement is the additional water required to the normal consumptive use of water by crops. Therefore,

$$D_{iw} = D_c + D_d \text{ -------------------------------- } (2)$$

Where,
D_c = Consumptive use of water

Using equation (3) to estimate D_d from equation (4)

$$D_{iw} = D_c/(1 - LR) \text{ -------------------- } (3)$$

Again, expressing the leaching requirement in equation (2) as EC ratio of irrigation and drainage waters, equation (3) stands as:

$$D_{iw} = [EC_d/(EC_d - EC_{iw})] \times D_c \text{ ---------------------- } (4)$$

The EC_{iw} can be known from chemical analysis of irrigation water and EC_d is taken based on permissible salt tolerance limits of the crop. The maximum concentration of salts considered permissible in the soil solution is 4 mmhos/cm. The estimated leaching requirements are usually high for saline waters, because they are based on a continuous leaching program.

Another equation for determining leaching requirements in soil

$$LR = \frac{EC_w}{5 \times EC_e - EC_w}$$

Relation between Leaching Requirement (LR), Available Water (AW) and Evapotranspiration (ET) is

$$AW = \frac{ET}{1 - LR}$$

Leaching requirement of saline soil:

The depth of irrigation water per unit depth of soil, required to produce any specified increase in salinity for any given conductivity of irrigation water can be estimated from the relationship is given below:

$$D_{iw}/D_s = d_s/d_w \times SP/100 \times \Delta EC_e/EC_{iw} \text{ ------------------------ } (5)$$

Where,

D_{iw} = Depth of irrigation water, cm
D_s = Depth of soil, cm
d_s = Density of soil (bulk density), gm/cm^3
d_w = density of irrigation water, gm/cm^3
ΔEC_e = Change in electrical conductivity of saturation extract of the soil
EC_{iw} = Electrical conductivity of irrigation water, µS/cm

Under high water table conditions, evaporation brings up the soluble salts and deposits the salts in upper layers of soil increasing the salinity. The change in salinity of the soil may be determined by the following equation:

$$\Delta EC_e = D_g/D_s \times EC_g/SP \times d_w/d_s \times 100 \text{ ------------------------ } (6)$$

Where,

D_g = Depth of ground water evaporated, cm
EC_g = Electrical conductivity of ground water, mS/cm

Equation (6) is derived from the relationship expressed in equation (5)

Leaching Method

- Leaching of soil is done by ponding water on the soil surface by bunds or borders and allowing a downward movement of water through the soil column.
- Rectangular checks and level borders are employed when the soil is level.
- Contour checks can be used when the land slope is more.
- Sprinkler irrigation is usefully employed to leach out salts especially when the soils are cracked and very permeable.
- Intermittent ponding of water is superior to continuous ponding of water for effective leaching.
- The efficiency of leaching depends on the amount of water applied, the uniformity of water distribution and the adequacy of drainage in the field.
- The sensitive crops or the crops with low salt tolerance have higher leaching requirement and require frequent leaching during a growing season. Leaching of salts once or twice in a growing season is enough for salt tolerant crops. It is usually needed to apply little more water than actually required by crops in areas where salinity is a problem. Occasional analysis of soil is required where irrigation water contains salts.

In areas where leaching is practiced for growing crops, fertilizers should be applied only after leaching is completed and in little higher amounts to make up the loss of nutrients during leaching of salts. The nitrogenous fertilizers are highly soluble and are prone to leaching.

In areas where salinity is a problem and leaching of salt is essential for crop growing, the drainage of land should be good. Usually, a high water table and the soil salinity occur simultaneously.

Planning of irrigation development should also consider the development of drainage in particular region. If the ground water is of good quality, the water the high water table can be pumped out and used for irrigation in the area or in the nearby areas.

The following relationships are often used to express the salt concentration of irrigation water.

- Salt concentration, mg/l or ppm = 640×EC, mmhos/cm
- Total cation concentration, me/l = 10×EC, mmhos/cm
  When EC is measured up to the range of 5 mmhos/cm at 25° C
- Osmotic pressure, atmospheres = 0.36×EC mmhos/cm
- Parts per million (ppm)/equivalent weight = me/l
  [me/l to ppm = sum of the product of the milliequivalent of each ion × its equivalent weight]
- Equivalent weight = Atomic weight/valency

Worked Out Problems:

Problem – 1

a) What is the classification of irrigation water having the following characteristics: Concentration of Na, Ca and Mg are 22, 3 and 1.5 milli-equivalents per liter respectively, and the electrical conductivity is 200 μmhos/cm at 25° C?
b) What problems might arise in using this water on fine textured soils?
c) What remedies do you suggest to overcome this trouble?

Solution:

(a) $$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}} = \frac{22}{\sqrt{\frac{3+1.5}{2}}} = 14.67$$

If SAR value is between 10 to 18, then it is classified as Medium Sodium Water and is represented by S2 (See table)
If the value of Electrical Conductivity is between 100 to 250 micro mhos per cm at 25° C, the water is called of Low Conductivity (C1) (See table)

Hence, the given water is classified as C1-S2 water (ans)

(b) In fine-textured soils, the medium sodium (S2) water may create the following problems:

(i) Soil becomes less permeable.
(ii) It starts crusting when dry.
(iii) It becomes plastic and sticky when wet.
(iv) Its pH increases towards that of alkaline soil.

(c) Gypsum ($CaSO_4$) addition, either to soil or to water is suggested to overcome sodium hazards posed by the given water.

Problem – 2
Express 8300 ppm of sodium salt concentration in mmhos/cm, µmhos/cm and mhos/cm

Solution:

We know, Salt concentration in ppm or mg/l of water = 640 × EC in mmhos/cm

$\therefore$ EC = ppm salt concentration/640 = 8300/640 = 12.97 mmhos/cm

= 12.97 × 1000 = 12970 µmhos/cm

= 12.97/1000 = 0.012 mhos/cm

Problem – 3
Express 2300 ppm sodium chloride salt concentration in me/l of water.

Solution:
We know,

Salt concentration in me/l = salt concentration in ppm/Equivalent weight ------------ (1)

Equivalent weight of NaCl = 23 + 35.45 = 58.45

From equation (1) $\Rightarrow$

$\therefore$ Salt concentration = 2300/58.45 = 39.35 me/l

Problem – 4
Work out the equivalence of 2.6 µmhos/cm Electrical Conductivity in osmotic pressure in atmospheres.

Solution:
We know, Osmotic Pressure (atm) = 0.36×Electrical Conductivity, mmhos/cm

= 0.36×2.6 = 0.936 atmospheres

Problem – 5
A sample of water from a well showed that it has an electrical conductivity of 1 mmhos/cm and a density of 1 gm/cm³. A field with a bulk density of soil of 1.48 gm/cm³ and saturation point of 36 percent will be irrigated. Work out the depth of irrigation that may turn the 30 cm depth of soil saline ignoring the precipitation and leaching of salts that may occur.

Solution:

$D_{iw}/D_s = d_s/d_w \times SP/100 \times \Delta EC_e/EC_{iw}$

$\therefore\ D_{iw} = D_s\,(d_s \times SP \times \Delta EC_e/d_w \times 100 \times EC_{iw})$

$= 30 \times [1.48 \times 36 \times 4/(1 \times 100 \times 1)]$

= 63.94 cm

Where,

$D_s = 30$ cm

$d_s = 1.48$ gm/cm³

$d_w = 1.0$ gm/cm³

SP = 36 %

$EC_e = 4$ mmhos/cm

$EC_{iw} = 1$ mmhos/cm

Problem – 6
Find out the leaching requirement of a soil when the Electrical Conductivity of the saturated extract of the soil is 9 mmhos/cm that caused 15 % reduction in yield of field pea. The EC of irrigation water is 1.2 mmhos/cm.

Solution:

LR (%) = $EC_{iw}/EC_d \times 100$

But, $EC_d = 2\ EC_e = 2 \times 9 = 18$ mmhos/cm

$\therefore$ LR = 1.2/18×100 = 6.7 %

This means that to maintain the soil salinity within the permissible limit, 7 % more irrigation water over the N.I.R is needed.

Practice Problems

1. A 5 gm soil sample on chemical analysis shows that it has 2.5 milliequivalents of exchangeable cations and 1.25 milliequivalents of exchangeable sodium ions. Determine the cation exchange capacity in me/100 gm soil and the exchangeable sodium in percent.

2. A 5 gm soil sample on reaction with 100 ml gypsum solution having a concentration of 32 me/l calcium showed that the filtrate contained 30.5 me/l of calcium and magnesium. Determine the gypsum requirement of the soil per hectare.

3. Estimate the possible change in soil salinity owing to evaporation of 9 cm ground water having an electrical conductivity of 10 mmhos/cm over a period of 3 months. The 30 cm depth of soil has a mean bulk density of 1.45 gm/cm^3 and saturation point of 40 %. The density of water assumed as 1 gm/cm^3. It is considered that the 30 cm depth of soil will be affected by the rise in salt concentration.

4. Calculate the irrigation requirement of a wheat crop when the leaching requirement of the wheat soil is 15 percent and the soil water has been depleted to 50 percent. The available water holding capacity of the root zone is 12 cm.