

## Groundwater Salinity

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Salinization is a major environmental adversity affecting soil and water resources, agriculture and creating disturbances in natural ecosystem. Increased groundwater salinity also related with high concentrations of some of elements like sodium, sulphate, boron, fluoride, selenium, arsenic and high radioactivity.<sup>1</sup> Salinity is a worldwide problem but becomes more brutal in water scarce arid and semi-arid areas where groundwater is the principal source of water. Increasing demands for groundwater resulting in depletion of water table and increasing salinity. In semi arid regions of Haryana and Punjab over exploitation of fresh groundwater resource causing declination of water levels leading to intrusion of saline water to these areas.


Groundwater salinity is generally of 3 types: (i) natural/primary salinity caused as a result of dissolution of minerals (e.g. halite, anhydrite, carbonates, gypsum, fluoride-salts, and sulphate-salts) from bedrocks or accumulation of salts from rainfall built up over time, hence the residence time of these may be quite long ranging from thousands to million of years<sup>2</sup> (ii) dry land/secondary salinity caused due to rising water levels which bring salt to the surface or clearing of vegetation cause accumulation of salt in soil profile and in groundwater. In high rainfall areas the salts are percolated down while in arid and semi arid regions these remain on the surface (iii) tertiary/irrigated salinity caused as a result of repeated multiple irrigation of water where salts remain after evaporation and accumulate over time. These accumulated salts leech down to groundwater with rainfall.

Based on the origin of salinity it may be classified as<sup>2</sup> (i) marine origin- these are mostly found in coastal zone and may be of connate or intruded (ii) terrestrial origin – natural, these may be due to evaporation, dissolution, and at depth there may be semi permeable layers or salt filtering membrane (iii) terrestrial

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origin – anthropogenic, irrigation and polluted groundwater (iv) mixed origin, these may be the mixing effect of any of above classes.

Salinity may be of various degrees based on the concentration of salts which also decides the purpose of groundwater use. Salinity is generally expressed as Total Dissolved Solids (TDS) grams of salts per litre but use of other proxies like Electrical Conductivity (EC- $\mu\text{S}/\text{cm}$ ) or chloride content (mg Cl per litre) is used extensively where EC and chloride content can be converted to TDS by multiplying a factor of 0.7 and 1.8, respectively.<sup>2</sup> Mayer *et al.*, (2005)<sup>3</sup> classified salinity as per table 1 on the basis of salt concentration.

**Table 1: Salinity classifications**

Salinity status	Salinity (grams of salt per litre)	Description and use
Fresh to marginal	< 0.5 - 1	Drinking and irrigation; apparent effects on ecosystem
Brackish	1 – 2	Irrigation certain crops only; useful for most stock
Saline to highly saline	2 – 35	Use for livestock with limitations
Brine	>35	Seawater; possible mining and industrial uses

Intrusion of saline water to the fresh water is a serious concern as this not only degrades our fresh water resources but also causes loss to the socio-economy of the region. Groundwater mobilises and carries the soluble salts through the regolith and mixes with the fresh water. There are various factors responsible for intrusion like- geological (in Indo-gangetic basin sedimentary region)<sup>4,5</sup> and/or meteorological processes, climate change effects (modifies meteorological variables like rainfall, temperature etc., impact by change in sea level, cause a global rise in atmospheric temperatures causing high evaporation thus intensifying risks of seawater intrusion), higher mineralization of recharge water, intensified formation of evaporate products, less intensive natural flushing, natural disasters like tsunamis and earth quakes, consolidation of compressible sediments; in addition to these there are anthropogenic factors, such as drainage, irrigation, groundwater pumping, waste or wastewater disposal, etc.

Salinity have effects like: problems of potable water, poor soil structures particularly due to sodium, less plant growth and yield, losses to infrastructure and ecosystems, socio-economic problems like loss of livelihood, unemployment, migration and food insecurity.

Therefore, this becomes very important to have an understanding of aquifer, groundwater movements and quantifying the extent of salinity expansion. For these the required information is: time of recharge, time frames/scales of salinization and input salinity. Various tools can be explored to gauge these parameters and isotopes can play an important role in solving issues of saline water intrusion, identifying sources of salinity, local contribution from unsaturated zones and dissolution of evaporates.

Groundwater salinity is increasing day by day, so there is an urgent requirement of water resource management in salinity affected areas. For management, following information is required:

- Aquifer geometry of the area to prepare inventory of occurrence of saline water depths, size etc.
- Monitoring of groundwater is an important step to find the water level fluctuations e.g decline in water table in fresh groundwater aquifers and water level rise in saline water affected areas. For this cluster of monitoring wells/piezometers may be installed.
- Map of saline area to get information on its spatial distribution
- Collection of information on agricultural practices and irrigation

- Hydro-geochemical characterization of groundwater
- Isotope can be used as tool for source identification
- After assessment of salinity, some management and remedial measures can be suggested such as: Managed Aquifer Recharge (MAR) or aquifer storage and recovery (ASR), Groundwater abstraction optimization, growing salt tolerant species, diversion of saline water to evaporation basins, developing habitats for halophiles, use for health and wellness purposes (thermo mineralized groundwater), salt productions etc.

Some engineered techniques are construction of barriers/impermeable screens by blocking the salt movement, to reduce water logging induced salinization by increasing groundwater level depth/increasing discharge or reducing the evaporation rates, reducing water consumption, drainage- (subsoil drains, ditches, lowering of water levels in surface water bodies) or biological drainage by planting high water consumptive vegetation like eucalyptus and acacia.

Some other techniques may be used are desalination of saline water by phase-change of membrane processes.

Conjunctive use of surface and groundwater is also one of the important options.

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