

Soil Genesis

- The mode by which soil originates, with particular reference to processes or of soil-forming factors responsible for the development of true soil from unconsolidated parent material. Also known as pedogenesis/ soil formation.

Genesis of Saline- Sodic Soils

- The mode by which saline- sodic soils originates due to different sources of salt.

OR

- The formation of salinity-sodicity in the soil from soluble salts/exchangeable sodium.

Sources of Salts

- There are different sources of salts which causes salinity/sodicity.
- Parent material & Weathering processes
- Irrigation water
- Flood waters & Waste effluent
- Sea water
- Lacustrine & Marine deposits
- Fossil Salts
- Chemical fertilizer & Waste materials

Differentiation

- *Primary salination/sodication*

- *Secondary salination/sodication*

"Accumulation of salts released during weathering is called primary salination/sodication".

"Accumulation of salts due to Tube wells and sewage water irrigation is called secondary salination/sodication".

Causes of Salt Accumulation

- The location of Pakistan is in arid and semi-arid climatic zones. Generally high evapo-transpiration in semi-arid and arid zones is the basic cause for salt accumulation on the soil surface.
- The average summer temperature is about 40°C and the minimum winter temperature remains between 2°C to 5°C. The annual rainfall varies between 100 mm to 700 mm throughout the country. The evaporation rate is generally very high and exceeds that of precipitation. Thus, the insufficient rainfall followed by high evaporative demand and shallow ground water depth, enhances the movement of salts towards soil surface.

Causes of Saline-Sodic Soils

- Formation of salination/sodication depends upon the Salt Balance (SB) and Water Balance (WB).
- Positive SB promotes formation of salt-affected soils while negative SB induces desalination/desodication.
- Positive WB causes rise in ground water table/water logging which promotes salt accumulation in the root zone and surface soil layers.

Foot notes
SB WB.

↑ SAST

Factors Leading to the genesis of Saline-sodic soils

Genesis of Saline-Sodic Soils

1. Inappropriate salt balance

Under the agro-climatic condition of Pakistan, salt balance remained positive, similarly water balance also remained positive up to few years back because of which large areas were waterlogged. However, from 1999 onward, water balance has become negative resulting in draw-down subsoil drying and thus decreased effluent has promoted soil salination and sodication.

Genesis of Saline-Sodic Soils

2. Nearness to sea

Nearness to sea is also one of the major causes of salt accumulation in soils but impacts are localized. Middle East countries e.g. Morocco, Oman, and UAE are seriously confronted with this situation. In coastal areas, soils get enriched with salts from sea through:

- Inundation of surface soil by sea water during high tide
- Ingress of sea water through Rivers etc.
- Ground water inflows and etc
- ☐ EC of Sea water = 45-50 dS/m, SAR = 50-55

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3. Arid Climate

Arid climate have generally high temperature which induce high evaporation and capillary action causing salt accumulation on soil surface and precipitation of salt (lime, gypsum etc.) in the root zone of crops.

4. Lack of Land Leveling

Uneven soils are also source of salination/sodication. Due to lack of land leveling, irrigation water is not distributed uniformly. After some years, lack of precision land leveling help the appearance of patchy salinity followed by sodicity (so called Slick-spot) just because of uneven distribution of irrigation water and/or Rain water.

Genesis of Saline-Sodic Soils

5. Poor Understanding of Water Quality Guidelines

Ignorance of Irrigation Water Quality Standards (IWQS), inefficient agricultural extension service and poor knowledge and skills of the farming communities are quite obvious in many developing countries. This problem is also lead to the formation of Soil Salination/Sodication.

Irrigation water and Rainfall

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| <ul style="list-style-type: none"> • Canal water ✓ Best quality water but it contains 120-200mg/L ✓ Its single irrigation of 10cm will add salts in the range of 120-180kg/ha | <ul style="list-style-type: none"> • Ground water ✓ It is mostly brackish but its level of EC, SAR and RSC are variable ✓ GW in Pakistan contains 1250mg/L ✓ Its single irrigation of 10cm will add 1.2 Mg salts/ha. |
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Rainfall

- Rainfall as a source of salts is of minor significance but its initial showers of rain after a long dry spells and around industrial town may contribute reasonable quantities of salts.

Genesis of Saline-Sodic Soils

6. Absentee Landlordism

Land lords could not take care of all their lands and a part is left uncultivated/un-cropped that may be subjected to salination/sodication with time.

7. Shallow water table

Mostly ground waters in arid regions are mineralized but to different extent and as a result of capillary effect, water continuously rises upward and enriches the surface soil with salt following evaporation and perhaps is the major cause of development of salty lands in irrigated areas.

Genesis of Saline-Sodic Soils

8. Socio-economic Factors

Political intervention, lack of stable Government policies, instable government, and lack of will, lack of soil/farmer-friendly policies and un-implementation of policies are areas because of which soil salination remain on the increase in several countries.

9. Untreated Municipal Effluent

Continuous use of untreated sewer water/municipal effluent or other drainage water for longer periods has the potential of inducing soil salination followed by sodication.

10. Extra crop coverage

- Extra crop coverage to meet the food requirements of increasing population, over years, gave rise to salt build in soils.

Genesis of saline, sodic soils

- Theoretically, ideal salt balance means that

$$\text{Salt Input} = \text{Salt Output}$$
$$SPM + Siw + Srw + Sfert + Smw + Smisc = Sl + Sppt + Scrop + Svolt + Smisc$$

PM = parent material, iw = irrigation water, ppt = precipitation, fert = fertilizer, mw = mineral weathering in-situ, misc = miscellaneous, l = leaching, crop = crop removal, vol = volatilization, S = salts

In this equation of salt balance, components Siw, Sl and Scrop are controlled by the human activities to a great extent. When salt input becomes greater than the salt output, salts start accumulating in soils (salination).