

GLOBAL PERSPECTIVE OF SALT-AFFECTED SOILS

Salt-Affected Soils

- Salt-affected soil is a general term used for those soils which have been adversely modified for the growth of most plants because of excess of soluble salts, exchangeable sodium (Na) or both.
- They are broadly classified into saline, sodic and saline sodic soils.
- Salt-affected soils are found under almost all types of climates. However, their distribution is wide spread and extensive in arid and semi arid regions as compared to humid regions.

Salinity in Gulf States

- Arab land occupies 1402 mha area
- Arable area is 197 mha (14.1%)
- Actually cultivated 70 mha (5 %)
- Irrigated land 9.5 mha
- Salt affected area 82.7 mha (42 % of arable)

Salinity in GCC (Gulf Cooperation Council) Countries

- Salt affected area in KSA 3641 mha
- Salt affected area in Oman 9.442 mha
- Salt affected area in Bahrain 41000 mha
- Salt affected area in Kuwait 85000 mha
- Salt affected area in Yemen 483000 mha
- Salt affected area in Qatar 70000 mha

Extension of Salt-Affected Soils in the World

- Nearly 50 million ha of cropland and pastures are currently affected by salinity and in some regions the area of land so affected is growing by about 10 % annually.
- Nearly 10 % of the total land surface is covered with different types of salt-affected soils.

Area of Salt-Affected Soils in Different Regions

Region	Area, million ha
✓ Africa	69.5
Near and Middle East	53.1
Asia and Far East	19.5
Latin America	59.4
✓ Australia	84.7
North America	16.0
✓ Europe	20.7
World Total	322.9
From Beek, et al. (1980)	

Africa 69.5
 Australia 84.7
 Europe 20.7
 North America 16
 Latin America 59.4
 N M East 53.1
 A F East 19.5

Salt-Affected soils on Continent and Subcontinent

Continent	Area, million ha
✓ North America	15.75
Mexico and Central America	1.97
✓ South America	129.16
✓ Africa	80.54
South Asia	87.61
North and Central Asia	211.69
South East Asia	19.98
✓ Australasia	357.33
✓ Europe	50.80
Total	954.83
Szabolcs, 1994	

Distribution of Salt-Affected Soils in the World

- It is evident from the table that no continent in our globe is free of salt-affected soils. They are distributed not only in desert and semi-deserts, but also frequently in fertile alluvial plains, river valleys and coastal areas close to densely populated areas and irrigation system.
- The rapid increase of world population and the demand for food by more than 6 billion people at the close of this century will make it imperative to exploit the land resources more intensively, but soil salinity defeats this goal. At the same time the area of arable land decreases in most countries, while the extension of salt-affected soils increases.

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- In the territory of nearly 100 countries there exist different types of salt-affected soils.
- GA **Europe:** Austria, Bulgaria, Czechoslovakia, Cyprus, France, Greece, Hungary, Italy, Portugal, Romania, Spain, Russia and Baltic states.
- **North America:** Canada and the USA.
- **South America:** Argentina, Bolivia, Brazil, Chile, Columbia, Paraguay, Peru, Venezuela.
- **Mexico and Central America:** Cuba and Mexico.

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- SST **Africa:** Algeria, Angola, Botswana, Chad, Cameroon, Egypt, Ethiopia, Gambia, Ghana, Guinea, Kenya, Liberia, Libya, Malgash Republic, Mali, Mauritania, Morocco, Niger, Nigeria, Portuguese, Guinea, Senegal, Sierra, Leone, Somalia, South West Africa, Tanzania, Tunisia, Zaire, Zambia, Zimbabwe.
- **Near and Middle East and South Asia:** Afghanistan, Bangladesh, Burma, India, Iran, Iraq, Israel, Jordan, Lebanon, Kuwait, Muscat and Oman, Pakistan, Qatar, Sarawak, Saudi Arabia, Sri Lanka, Syria, Turkey, Yemen.
- CMB **North and Central Asia:** China, Mongolia, Russia and Baltic states.
- **South East Asia:** Cambodia, Malaysia, Thailand, Vietnam.
- **Australasia:** Australia, Fiji, Solomon Island.

Salt-Affected Soils in Pakistan

- Pakistan spreads over an area of 79.61 million ha.
 - Almost 70 % of the country falls under arid and semi-arid regions.
 - In irrigated belt salinity is threatening about 6.68 m ha.
- (Soil Survey of Pakistan, 1998)

Sr. #	Category	Punjab	Sindh	Baluchi stan	NWFP	Pakista n
1	Saline sodic porous	1.1070	0.3185	0.1654	0.0316	1.6225
2	Saline sodic dense	0.8358	0.0395	0.0022		0.9275
3	Saline sodic gypsiferous					
I	Porous	0.0507	0.0214	0.1931	-	0.2652
II	Dense	0.0570	0.0269	-	0.0075	0.0914
4	Saline	-	0.3351	0.6363	-	0.9714
5	Saline gypsiferous					
I	Porous	0.1666	1.2454	1.3167	-	2.7287
II	Dense	-	0.0733	-	-	0.0733
	total	2.2171	2.1101	2.3137	0.0391	6.6800

Distribution of Salt-Affected Soils in Pakistan
(m ha), Mirza and Ahmad, 1998

Soil Type	Irrigated	Non-Irrigated	Total
Punjab	1.51	1.16	2.67
Sindh	1.15	0.96	2.11
NWFP	0.93	0.02	0.95
Baluchistan	0.11	0.39	0.50
Pakistan	2.80	2.53	5.33

Classification Salt-Affected Soils

Shahrish nawaz

Classification of Salt-Affected Soils

There are various systems of classification of salt-affected soils into different groups which are as under:

- USDA system
- USSR system
- European system
- Australian system
- FAO-UNESCO system
- Indian system
- Pakistan system
- Soil Survey of Pakistan (SSP)
- WAPDA
- Directorate of Land Reclamation (DLR)

USDA system

- The US Salinity Laboratory Staff (1954) classified soils into 3 classes namely saline, sodic and saline sodic.
- Since 50 % reduction in yield takes place at EC_e of 4 dSm^{-1} for several agricultural crops.
- This was purposed critical value to distinguish saline from non- saline soil.
- The physical properties ,especially the permibility of soil were significantly affected at $ESP > 15$ and the same was taken has critical value differentiating sodic from nonsodic soil.

USDA classification (US Salinity lab staff,1954)

Soil Type	EC_e (dS m^{-1})	ESP	SAR	pH
Saline	≥ 4	< 15	< 13	< 8.5
Sodic	< 4	≥ 15	≥ 13	≥ 8.5
Saline sodic	≥ 4	≥ 15	≥ 13	≥ 8.5

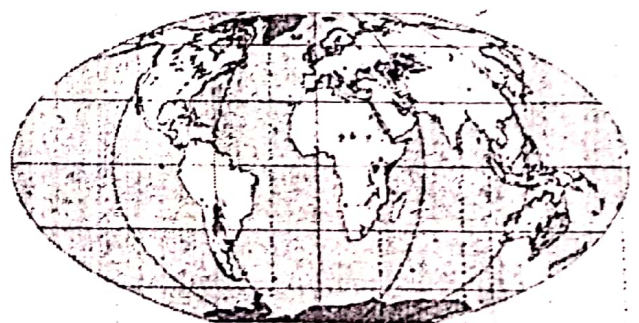
USSR system

In the former USSR, salt-affected soils have been classified into 2 groups like solonchak and solonetz.

- ❖ Solonetz soils: These soils are characterized by high ESP in the B horizon. Mainly base on type of clay minerals and ESP.

These soils have been divided in to four categories:

Solonetz soils



Dominant
 Associated
 Inclusions
 Macelleracous lands (strand waterbodies, Glaciers, No data)

Map Polar Quercus Projection

FAO-UNESCO, February 1988

10/18, 30 5, 10 16

slightly

W

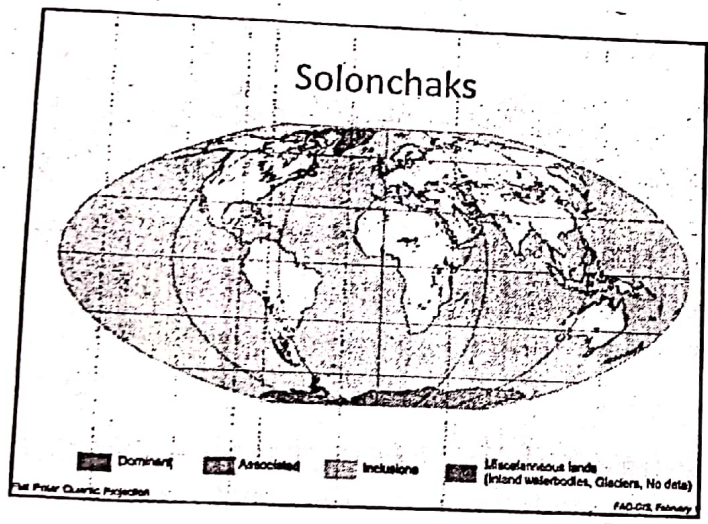
USSR system classification of solonetz soils

Category	ESP
Weakly solonetzic	<10
Moderately solonetzic	10-15
Strongly solonetzic	15-30
solonetz	≥30

Chernozem soils Chestnut and Brown soils

Solonchak soils

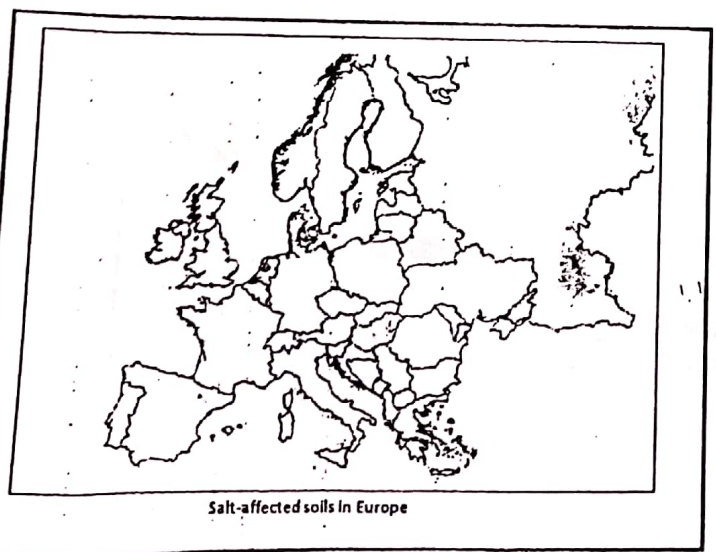
- These soils are defined as those containing > 2 % soluble salts in the upper 30cm soil. Further more depending upon the salt content and type of soluble salts. Five category have been distinguished (saline, non-saline, slightly moderately and strongly saline and solonchak).
- Relationship between total salt contents and category depend upon mixture of salts present. Thus, depending on type of total soluble salts, slightly saline soil may contain 0.1-0.6%, while solonchak contain salt varying from 0.5-2%.



European system

In addition to the limits of EC_e , ESP and pH_e of the US Salinity Laboratory Staff, the Europeans introduced a genetic parameter, i.e. structure of B horizon and included two more groups in the scheme of classification.

- > Saline soils: Soils with or without structural B horizon.
- > Sodic soils: Soils with or without structural B horizon.



Australian system

The Australian scientists classified salt-affected into saline, sodic and alkaline soils mainly on the basis of percent salt contents, ESP and pH_e of soils. (McIntyre, 1979; FAO, 1974).

Soil type	Category 0	Category 1	Category 2
Saline soil based On % salts	Non-saline, <0.1% NaCl	Saline loam > 0.1% NaCl Clay > 0.2% NaCl	Highly saline, >0.3% NaCl in B Horizon
Sodic soil based On ESP	Non-sodic, <6	Moderately sodic, 6-14	Highly sodic, >14
Alkaline soil based On pH	Non-alkaline, <8.0	Alkaline, 8.0-9.5	Strongly alkaline, >9.5

FAO-UNESCO system

In this system salt-affected soils are grouped into 2 categories.

Solonchak soils

This group is characterized by high salinity within 125cm of surface layer. High salinity is defined as an $EC > 15 dSm^{-1}$ at sometimes of year within 125, 90 or 75cm of surface in soils with coarse, medium or fine texture top layer respectively.

or an $EC > 4 dSm^{-1}$ within 25cm of surface soil.

Solonetz soils

These soils are defined as having

- Natric B Horizon in upper 40 cm of which $ESP > 15$ or
- Exchangeable Na^+ , Mg^{++} , more Ca^{++} exchange acidity at pH 8.2 within the upper 40cm of horizon and an $ESP > 15$ in some sub horizons within 2cm of the surface.

Indian system

- Indian scientists consider the nature of soluble salts as an important index for grouping salts affect soils. They argued that pH_s of 8.5 is too high, as the iso-electrical pH for precipitation of $CaCO_3$, at which the sodification process starts, is 8.2 and mostly this pH is associated with ESP of 15 or more.
- Base on the nature of the major problems. Plants face for their optimum growth and the strategy for their reclamation, soil previously classified as saline-sodic because of high pH_s, ESP, and E_c , are treated as saline or alkali.
- In Indian system of classification, soils are categorized as under:

Indian Soil Classification system

Property	Saline soil	Alkali/Sodic soil	Saline sodic soil
pH _s	< 8.2	≥ 8.2	-
ESP	< 15	≥ 15	-
EC _e (dS m ⁻¹)	≥ 4	Variable, mostly < 4	-
Nature of soluble salts	Natural, mostly Cl ⁻ and HCO ₃ ⁻ present but is absent	Capable of alkaline hydrolysis, preponderance of HCO ₃ ⁻ & CO ₃ ²⁻ of Na ⁺	-

Pakistan system

- In Pakistan, different classification schemes of salt-affected soils are being followed by different departments.

Soil Survey of Pakistan (SSP)

SSP follows the limits of pH, EC and SAR as proposed by USDA to differentiate saline, saline sodic and sodic soils.

WAPDA

In this system, classification of salt-affected soils is mainly based on EC_e without any consideration of SAR, pH or any other soil characteristics.

WAPDA

Class	Name	EC _e (dS m ⁻¹)
S ₀	Salt free	< 4
S ₁	Slightly saline	4-8
S ₂	Moderately saline	8-12
S ₃	Strongly saline	12-16
S ₄	Very strongly saline	> 16

Directorate of Land Reclamation (DLR)

- DLR is the first ever organization established in the Indian Subcontinent to deal with salt-affected soils.
- This department classifies the soils on the basis of visually observed salts on the surface of soils mostly surveyed during the months of March-April each year mainly by "Canal Patwaries" a non technical person for this job.
- The following classes are included in this system.

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Thur Kohna: Land which has never been brought under cultivation due to salinity.

Thur Panjsala: Land which has gone out of cultivation for more than last five years.

Thur Nau: Land which has gone out of cultivation during the preceding five years.

Thur Juzvi: Land under cultivation having visible patches of salts to the extent of 20 % of an acre.

Thur Tirk: Land where salts in the root zone hampers the opening of cotton bolls.

