Salt Affected Soils in India, their Nature and Distribution

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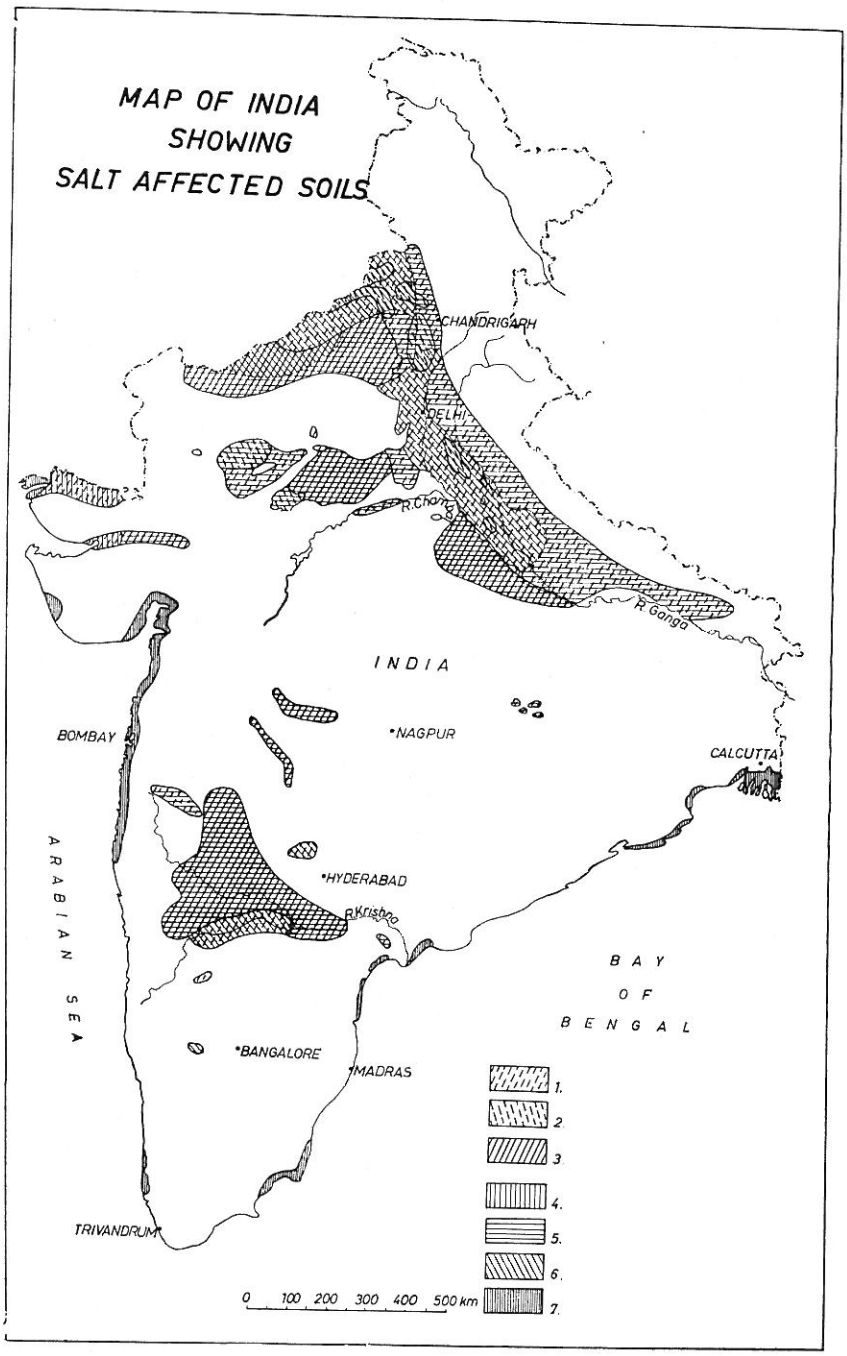
The salt affected soils of India usually occur in association with the normal zonal soils of the arid and semiarid regions. They occur in wide belts or as patches of varying expanse often associated with hydrological or topographical features. At times they are extremely variable and salinity conditions frequently change even over relatively short distances. The occurrence of salts on the surface is also a seasonal phenomenon. The salts become more conspicuous during the dry season, particularly during the winter in North India. When the deterioration of the soil has gone to the extreme and alkalinisation has taken place the salts may or may not become evident on the surface.

About 15 million acres of soil are reported to be affected by salinity in different states in India. They are characterised by salinity or salinity and alkalinity of varying degrees (Planning Commission Report [4]).

There are no correct estimates of the area of saline alkali soils in India. Most of the estimates are based on revenue records. Revenue officials are required to record an eye judgement of percentage deterioration in the soil. In new irrigation projects, pre-irrigation surveys have been done, which indicate large areas of irrigation projects which are likely to be affected by salinity as the salts are present in the profile at various depths. Moreover, even in other areas, where at present the salinity problem may not exist, salinity is becoming a serious problem because of faulty water management. The use of even very good quality water in course of time leads to the accumulation of salt, the toxic elements of which begin to effect the crop much earlier than does total salinity.

The quality of water rating for agriculture is being done everywhere in India, but no systematic survey of the quality of underground water has been made. The available information was compiled by KANWAR [4] and it indicates that in large tracts of the arid part of the country, the quality of irrigation water is quite saline. However, this water can be used for irrigation by keeping in mind the nature and properties of the soil, crop, climate and the nature and amount of salts in the water. Moreover, the monsoon pattern of rains affects the behaviour of saline irrigation water and the serious adverse effect anticipated in temperate climates by the use of such water is not experienced.

The Waste Land Survey Committee has tried to assess the extent of saline alkali areas in different states and to identify the blocks of 500 acres or more which may be reclaimed. This information is quite useful from the point of view of development.



Legend of "Map of India showing Salt Affected Soils."
1. Saline soils. 2. Saline alkali soils. 3. Potential saline soils. 4. Area > 50%. 5. Area 20—50% 6. Area < 20% 7. Coastal saline soils area < 20%.

Available information about the extent of saline and alkali soils and their distribution is given in Map I. There are at present many gaps in our knowledge. It may not be out of place to mention that a Central Soil Salinity Research Institute has been established at Hissar (Haryana) by the Indian Council of Agricultural Research with its three regional centres representing coastal saline, alluvial and black soils. This Institute is required to collect more precise information about the extent and distribution of the saline alkali soils, besides developing techniques for their utilization.

A) Distribution of saline alkali soils: The principal areas of occurrence of saline alkali soils in India are (i) the arid alluvial tracts of Punjab, Haryana and Rajasthan in the north and west, (ii) the Ganges Valley, West of about 80° of East in the States of Delhi and Uttar Pradesh, representing the alluvial soil of semi-arid regions, (iii) the arid and semi-arid uplands of the Deccan Plateau especially between the Tapti, Godavari and Bhima rivers falling partly in Maharashtra, Mysore and Andhra Pradesh, (iv) coastal saline soils in the deltas of the Ganges, Godavari, Krishna, Cauvery and Mahanadi rivers, in the State of West Bengal, Orissa, Andhra Pradesh and Madras (Tamil Nadu), (v) coastal salt flats along the Rann of Cutch and (vi) acid saline soils in the back-waters of Kerala State.

Details regarding the distribution of salt affected soils in different districts of Indian States are given in appendix 1 (FIREMAN and RAMAMOORTY [3]).

It is estimated that in Uttar Pradesh about four million acres are lying waste because of saline and alkaline conditions. This is the largest area in any single state in India. These lands are mostly located in the region lying to the south west of the river Ganges. The worst affected districts are Mainpuri, Aligarh, Etah, Farrukhabad, Etawah, Kanpur, Unnao, Fatehpur, Allahabad, Rae-Bareli, Lucknow, Partapgarh, Sultanpur and Hardoi. There is also a stretch of low-lying land extending to the sub-humid parts of the State comprising the district of Azamgarh, Western Ballia, Northern Ghazipur and the Bhadhoi taluk of Varanasi district where salinity is due to a rise in water table.

The total area affected by salts and alkali including all stages of deterioration as revealed by the revenue records and soil survey by the Irrigation Department of the joint Punjab and Haryana is about 3.0 million acres (Uppal 1962) as per details (Table 1).

Table 1

	Acres
1. Saline areas recorded by irrigation branch within the irrigation boundary as a result of visual examination	483,427
2. Saline area recorded by Civil Dept. outside irrigation boundaries (1957)	138,219
3. Area found in various stages of deterioration as a result of 33 million-acre survey by Bhakra Scientific Soil Survey and Karnal District Special Survey	1,128,000
4. Area found in various stages of deterioration as a result of 1.02 million surveyed in erstwhile PEPSU, Bhakra area plus Surhind Canal area	1,160,439
Total	2,910,085

The Rajasthan, Pali, Bhilwara, Bharatpur, Ajmer, Alwar, Jaipur, Jodhpur, Jolor, Tonk, Nagor, Sirchi and Chittorgarh districts are reported to

Appendix. I

Name of the State	District or area of major saline and alkali problem	Elevation in Feet	Relation to river system	Climate	
				Rainfall (inches)	Temperatue (mean annual) °F.
1. Punjab	Gurdaspur Alluvium	200—500 ft	Between the Ravi & Beas rivers	25—40″	
	Amritsar District	200—500 ft	Between the Ravi & Beas but intercepted by a large number of main canals	21—30″	
	Ferozepur District	Less than 500 ft 0—200 ft and 200—500 ft	All between the Sutlez and the natural drain or canal parallel to it in the district	15—24″	
	Kapurthala	200—500 ft	Between the Beas and the Beins	22—30″	
	Ludhiana	200—500 ft	Between the Sutlez and local rivulets and canals	22—29″	76
	Jullundur	200—500 ft	Between the White or East Bein and Sutlez	24—35″	
	Patiala	200—500 ft	All between Ghagger and Saraswati and other local rivulets	26—34″	
2. Haryana	Hissar	200—500 ft	Between the Ghagger and other local rivers	18—23″	77
	Rohtak	200—500 ft	Between the Jamna and other local rivulets and canals	23—28″	
	Gurgaon	200—500 ft	Between the Jamna and local canals	25—28″	
	Karnal	200—500 ft	Between Jamna and other local rivulets	27—35″	
3. Uttar Pradesh	Muzaffarnagar	200—500 ft	Between Jamna and Ganges and Hindon rivers	28—40″	
	Meerut	200—500 ft	Between Ganges river and the Jamna river	28—34″	75.8
	Bulandshahr	0—500 ft		28—32″	
	Aligarh	0—200 ft		28	
	Part of Mathura	0—200 ft		< 28	
	Etah	0—200 ft		28—32″	
	Mainpuri	0—200 ft	Between Ganges river and the Jamna river	28—32″	77.9
	Farrukhabad	0—200 ft		32—36″	
	Etawah	0—200 ft		30	
	Kanpur	0—200 ft		30—32″	77.8
	Fatehpur	0—200 ft		32—36″	
	Allahabad	0—200 ft		40	78.2
	Hardoi	0—200 ft		36	
	Unnao	0—200 ft	Betwen the Ganges & Gomati rivers	32—36	
	Lucknow	0—200 ft		36—40	77.9
	Rai Bareilly	0—200 ft	Between the Ganges & Gomati rivers	36—40	
	Sultanpur	0—200 ft		40—42	
	Partapgarh	0—200 ft	Between the Ganges and Gomati rivers	36—40	
	Jaunpur	0—200 ft	Between the Ganges and Gomati rivers	40	
	Azamgarh	0—200 ft	Between Gomati and Ghagra rivers	41—46″	

4. Bihar	Banaras	0—200 ft	Between Gomati and Ganges	<40	78.2
	Saran	0—200 ft	Between Ghagra and Gandak and Ganges	41—44	
	Muzaffarpur	0—200 ft	Between Buhri Gandak and the Ganges	44—46	
	Darbhanga	0—200 ft	Between Burhi Gandak and the Ganges and Kamla rivers	46—50	77.1
5. Rajasthan	Pali	200—500 ft	Several tributaries of Luni river	16—22	
	Bhilwara	200—500 ft	Between tributaries of Banas river	21—26	
	Bharatpur	200—500 ft	Local rivers of Jamna and Gambhir	27	
	Ajmer	200—500 ft	Kheri river and other tributaries of Banas river	24	76.7
	Alwar	200—500 ft	Sabi and other local rivers		
	Jaipur	200—500 ft	Salt lake and local rivers and tributaries of Banas river	24	77.3
	Jodhpur	200—500 ft	Tributary of Luni river	14.2	79.2
	Jalor	0—200 ft	Several tributaries of Luni river		
	Tonk	200—500 ft	Banas river and its tributaries		
	Nagor	200—500 ft	Salt lake and tributaries of Luni river		
	Sirohi	200—500 ft	Tributaries of Luni		
	Chittorgarh	200—500 ft	Banas river and its tributaries		
6. Gujarat	Banas Kantha	0—200 ft	Banas and Luni rivers	<25	
	Mehsana	0—200 ft	Between Banas Sabarmati and their tributaries	27.5	
	Ahmedabad	0—200 ft	Sabarmati river and small local rivers	30	81.4
	Kaira	0—200 ft	Between Sabarmati and Mahi rivers	30	
	Surat	0—200 ft	Tapti river	50	
	Broach Coastal Area	0—200 ft	Sea and Tapti river sea coast	40	
	Amreli Coastal Area	0—200 ft	Sea and Tapti river sea coast		
7. Maharashtra	Khandesh	0—500 ft	Tapti and Narmada	30	
	Surat	0—500 ft	Sea coast	40—60	81.0
	Thana	0—500 ft	Sea coast	60—90	
	Kolaba		Sea coast	100	
	Ratnagiri		Sea coast	100	
8. Mysore	Sholapur Western Ghat	200—500 ft	Bhima River and tributaries	25	80.6
	Dharwar	200—500 ft above	Tungabhadra and Malaprabha Valley	25—50	
	Bijapur	200—500 ft	Bhima and Dhone rivers	20	79.4
	Raichur	200—500 ft	Tungabhadra and its tributaries	25	82.2
	Mandya	500—100 ft	Cauvery river and reservoir		
9. Andhra Pradesh	Krishna Delta area	0—200 ft	Sea coast	42	
	Nizamabad area	200—500 ft	Godavari and its tributaries	28—33	
	Mahbubnagar	200—500 ft	Krishna river and tributaries	29	
	Nalgonda	200—500 ft	Musi river and other tributaries of Krishna river	30—34	
10. Tamil Nadu	Tanjore	0—200 ft	Cauvery river and Sea	50—60	
11. Orissa	Balasore	0—200 ft	Sea coast	57—60	
12. West Bengal	Sundarbans Marshes	0—200 ft	Sea coast	57—67	79.4
13. Delhi	Delhi	200—500 ft	Jamuna river and its canals	26	76.7

contain saline and alkali soils. Salinity is more prevalent than alkalinity, but due to irrigation the alkali problem is becoming more serious. In Gujrat, the districts of Banas Kantha, Mehsana, Admedabad, Kaira, Surat, Broach, Amroti and some coastal areas, have salinity and alkalinity problems.

In Maharashtra State, Khandesh, Stara, Sholapur, Thana, Kolaba and Ratnagiri districts are reported to have salinity problems. Except in the first three districts, the problem is mainly due to the incursion of sea water.

Mysore State has a salinity problem in Dharwar, Bijapur, Raichur, Bellary and Mandya.

In Andhra Pradesh, the Krishna Delta area and the Nizamabad, Mahbubnagar and Nalgonda districts have a salinity problem.

Tanjavur district in Madras (Tamil Nadu), Balasore in Orissa and Sundarbans in West Bengal suffer from salinity. In Delhi territory salinity and alkalinity are both found.

B) Potential salinity: In many soils of arid areas, salts occur at depth in the profile. As a result of the introduction of irrigation with inadequate leaching and low soil permeability perched water tables may develop and bring the salt to the surface. Thus as a result of the extension of irrigation, more and more areas are becoming salt affected.

Irrigation, particularly in Punjab, Haryana, Delhi, U. P., Rajasthan, Gujrat and Maharashtra, has considerably aggravated the problem of salinity and alkalinity. Even in the black and the red soil regions of the Deccan Plateau, in the new irrigation project areas a salinity problem is rapidly developing. In the coastal area changes in salinity are seasonal depending on the tides and the monsoons.

C) Classification of saline-alkali soils: Various attempts at the classification of saline-alkali soils have been made in India. Work done on saline-alkali soils has been compiled by AGARWAL and GUPTA [1].

BASU and TAGORE [2] classified the alkali soils of the black cotton areas in the Deccan canals under the world soil group "alkali" soils with solonetz structure. However, the morphological features of these soils are reported to be somewhat different from those of typical Russian solonetz.

In the Gangetic alluvium of the Northern Indian States the principal processes operating are those of salinization and desalinization. In the riverine tract, where salt is a problem, the process is one of salinization whether it is of the "carbonate-chloride" or "sulphate-chloride" type. These soils exhibit all the features of immaturity.

KANWAR and SEHGAL [5] classified the salt affected soils of Karnal into 5 typical series. They represent the typical salty soils of Punjab and Haryana. Their distinguishing chemical features are summarised in Table 2.

Some characteristics of a typical saline-alkali soil of Punjab, which is not affected by a water table and which shows the effect of past geological and soil forming factors, are given in Table 3.

Coastal saline soils: Coastal saline soils are found along the long coast line of about 35,00 miles. The problem occurs in varying degrees in the states of West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra and Gujrat. The important tracts of coastal saline lands are Sunder Bans of West Bengal, the deltas of the Krishna, Godavari, Cauvary and Kari soils of Kerala, Khar lands of Maharashtra and Gujrat and the salt flats of Runn of Kutch.

Table 2

Distinguishing features of salt affected soils of Karnal district

Soils series	pH (SP)	EC of A-horizon ($EC \times 10^3$)	Sol. carb. + bicarb. % of anions.	Sol. $Cl^- + SO_4^{2-}$ % of anions.	ESP	Depth of water table (cm.)
Parri	<8.5	8.3	0 to 10	>90	15 to 30	<5
Dadu Pur	8.5 to 9	30.6	0 to 10	>90	15 to 30	<2
Azizulpur	9 to 10	124.0	10 to 20	90 to 80	50 to 80	2.5 to 5
Qawi	9 to 10	14.2	40 to 60	60 to 40	50 to 80	1.5 to 2.5
Bhawani Khera	10 to 105	30.9	>80	<20	>80	1.5 to 2.5

The saline soils of Sunder Bans in West Bengal resulted from inundation by brackish sea waters. In Kerala, the Kari soils are peaty in nature containing 10 to 40 per cent organic matter. These are low lying and remain submerged

Table 3

Analytical data for saline-alkali soil of Punjab

Depth in cm Kamma (Ludhiana)	Saturation percentage	pH	Electrical conductivity of saturation extract of soil	Exchangeable sodium percentage
0 to 20	31	9.4	7.39	77
20 to 60	30	10.0	11.70	87
60 to 108	37	9.4	4.09	82
108 to 180	31	8.9	1.53	—

during the monsoons. The soils are alluvial in nature. These low lying tracts are believed to have been once part of the sea and were formed by gradual silting with sediment brought down by rivers. The Khar and Khajar lands

Table 4

Analytical data for saline-alkali soil of U.P.

Depth in cm	pH 1 : 2.5 soil water suspension	Saturation percentage	Saturation extract			CEC per 100 g soil me.	ESP
			EC mm.hos/cm	Soluble Na me/litre	Soluble sodium percentage me.		
Carbonate-Chloride type Malihabad (Lucknow District)							
0— 30	11.5	43.4	16.83	155.9	92.6	13.28	45
30— 68	11.4	38.4	13.77	129.4	94.0	10.32	45
68—120	11.2	40.0	15.78	154.1	97.7	13.36	60
120—140	10.8	44.3	13.06	126.1	96.6	11.92	43
Carbonate-Sulphate type Kasimabad (Hardoi District)							
0— 22	10.9	38.7	2.913	27.1	93.1	10.00	23
22— 52	11.2	49.8	1.377	10.7	77.5	11.76	12
52— 77	10.8	58.0	2.525	23.5	92.9	8.40	21
77—180	9.9	47.1	1.761	14.2	80.7	5.84	13

of Maharashtra and Gujrat are subjected to periodic inundation by tidal water. They developed by gradual silting with sediment brought down by rivers draining to the sea. BASU [2] divided these saline lands into 3 categories AGARWAL [1].

a) Natural saline soils from salt bearing parent material or beds affected by sea water in the past caused by arid climate, topographic situation, nearness of saline sub-soil water and impervious sub-soil conditions.

b) Saline soils formed by irrigation and salt incrustation generally with sodium sulphate and sodium chloride.

c) The soils on the coastal area rendered saline by inundation by sea water.

The saline-alkali soils of U. P. are found generally in low-lying pockets of the uplands. Internal drainage is obstructed due to the presence of hard or indurated sub-soils which are more or less impermeable to water. The hard indurated layer is either a clay pan or a caliche layer at a depth ranging from a few inches to a few feet. The texture of the soil may be loam to clay loam, but the sub-soils are heavier in texture. The surface may even be sandy loam. Analytical data for saline-alkali soils of U. P. are given in Table 4.

The data indicate that in these soils the soluble salts of sodium are predominant.

References

[1] AGARWAL, R. R. & GUPTA, R. N.: Saline alkali soils in India. Indian Council of Agricultural Research. New Delhi Tech. Bulletin **15.** 1968.

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[3] FIREMAN, M. & RAMAMOORTHY, B.: A comparison of the major saline and alkali areas in India with those in U.S.A. Seminar on salinity and alkali soil problems. 1962.

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Corrigendum

In the Supplement of Tom **18** of ,,Agrokémia és Talajtan'' on the Yerevan Symposium on the ,,Reclamation of Sodic and Soda-Saline Soils'' a paper has been published, written by. J. S. Kanwar under title ,,Salt Affected Soils in India, their Nature and Distribution'' (p. 79—86). A map, entitled ,,Map of India Showing Salt Affected Soils'' has been given in this paper. For purpose of convenience, the map was adapted by the Editoral Board out of the one prepared India and adjoining countries by Dr. S. V. Govindarajan, Chief Soil Survey Officer, All India Soil & Land Use Survey Scheme. The author (Kanwar) has found some omission in this adaptation. The map does not show the whole of India on page 80 but only those States of it which have the salt affected soils. The Indian States like Assam, Tripura, Manipur, Nagaland, NEFA, Meghalaya, etc. have been excluded from the map as they do not have much of the salinity problem. Therefore, he has suggested that the correct title of map on page 80 should be as: ,,A Map of certain parts of India showing salt affectes soils''. The Editoral Board accepts this view and the title of the map may be read as underlined above.