

Taxonomy and Distribution of Arid Soils of Rajasthan

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Abstract: A soil map of arid zone of Rajasthan is presented based on updated soil survey information and refinement of boundaries from dry season (April-June) FCCs. Latest version of Soil Taxonomy has been used in the classification. In all, 30 units have been mapped. The Entisols and Aridisols constitute 51.84% and 41.05% of the total area, respectively. Amongst the Entisols, Torripsamments (dune and hummocky plain) are the most dominant. The Aridisols are mainly made up of Cambids and Calcids, within which newly proposed Psammentic and Typic Haplocambids, Typic Haplocalcids and Typic Petrocalcids subgroups are extensive.

Key words: Arid Rajasthan, soils, soil taxonomy, soil map.

Sand dunes and sandy plains with a very weak manifestation of pedogenesis are the dominant features of arid Rajasthan, but aggraded plains and buried pediments cover significant areas in the south-eastern and central parts. Here the source rock-dependent variations in parent material and a long period of arid to semi-arid geomorphic processes during complex landscape evolutionary history resulted in a variety of fairly well developed soils. Many of these were identified and mapped during soils survey by the Central Arid Zone Research Institute (CAZRI) and the State Government Departments during the past 35 years and more. Roy and Sen (1968), Mathur *et al.* (1972), Dhir and Mann (1978) and Lodha *et al.* (1982) attempted to synthesize the information to generate regional soil maps, though with certain limitations. The present effort makes use of soil profile characteristics and soil distribution information that has since become available for almost the entire region to classify and

map the soils at family level category of Soil Taxonomy, USDA (Soil Survey Staff, 1992).

Materials and Methods

The morphological and physico-chemical characteristics of the soil series were used for classification of soils into groups, sub-groups and families of Soil Taxonomy (Soil Survey Staff, 1992). In certain cases the Taxonomy was found dissatisfactory as the existing criteria were unable to separate the soils of somewhat variable behavior and pedogenetic characteristics. The existing soil maps, mostly at 1:250,000 scale, were redrawn with soil family as the mapping unit. The soil boundaries were evaluated with the help of 1:250,000 scale dry season (April-June) satellite imagery. The imagery was also used for extrapolation of soil boundaries for the unsurveyed parts of Ganganagar and Churu districts. The maps were then reduced to 1:1 million scale and finally to 1:2 million scale. No taxonomic unit had uniform spatial cov-

erage, and included smaller soil units which are difficult to depict separately on the small scale map. This necessitated a grouping and the final mapping unit became a soil association unit. In all 30 mapping units were recognized and mapped. The boundary of arid zone was adopted from Krishanan (1968).

Results and Discussion

To facilitate comprehension, the contents are split into three components, viz., (i) application of Soil Taxonomy, problems encountered therein and the suggested modifications; (ii) soil map; and (iii) the extent of different mapping units.

Application of soil taxonomy

Soil Taxonomy, the comprehensive system of classification, was found valid for most of the soils recognized and mapped in the arid zone. However, in some cases, difficulties were encountered. A brief account of the problems, as well as the suggested modifications are discussed below.

Problem due to fine sandy/very fine sandy texture: The central part of arid zone is mostly covered by a thick mantle of aeolian sand of late Pleistocene age. The soil profile development here is marked by accumulation of lime, formation of a nodular calcic horizon and a weakly developed sub-angular blocky structure in B horizon. The soils appear as a zonal formation and have been described as desert soils (Raychaudhuri *et al.*, 1963) and light brown sandy (Dhir, 1977). However, the texture of B horizon is only loamy fine sand and not loamy very fine sand or finer and therefore, fails to qualify as a cambic horizon. These soils are classified as Entisols, i.e., those which

hardly have any genetic features, like the soils of sand dunes of the Recent period. The anomaly was pointed out by Dhir and Jain (1982). In order to overcome this situation, Sehgal *et al.* (1986) proposed an enlargement of the textural range of the cambic horizon and yet to maintain the textural distinctiveness, suggested a new sub-group Psammentic Haplocambids.

Problem of calcareous soils: The Luni basin and some areas outside it in the south-eastern part of Nagaur district have soils which have a calcareous, well developed structural B horizon associated with calcic horizon. These soils can not be classified as Cambids because of the presence of a well developed calcic horizon, nor as Calcids as no sub-horizon above the calcic horizon is free of lime. Further Soil Taxonomy does not provide a precise criterion for calcareousness, i.e., it does not specify the minimum limit of lime that ought to be present in solum to qualify as calcareous. Keeping in view the morphology and range of mean lime content of solum, a mean profile value of 5% is suggested as the dividing line between Cambids and Calcids. Further, to separate calcareous Cambids from the non-calcareous ones, a sub-division can be made at the family level.

Problem of salt-affected soils: The Luni basin has nearly 5807 sq. km of naturally salt affected land. These are mostly medium textured and have a structural B horizon. The soils are highly charged with salts dominated by sodium chloride and often have highly saline ground water within 4 m of the surface. The mean profile salinity ranges from 8 to 40 dS m⁻¹

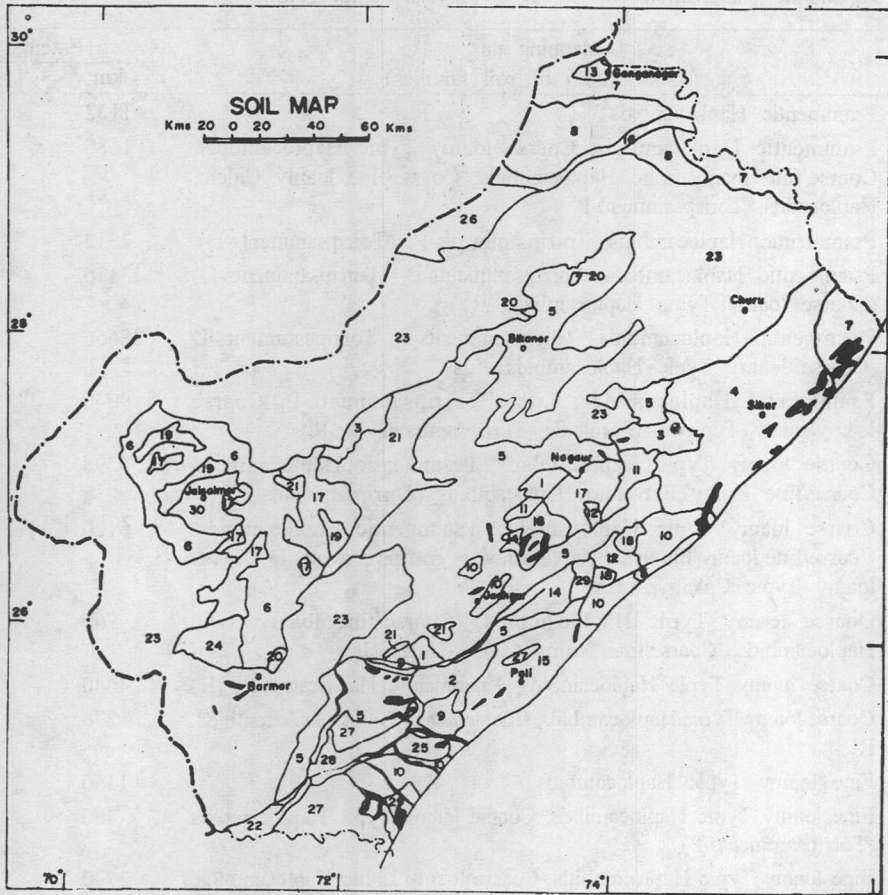


Fig. 1. Soil families association in arid Rajasthan.

Soil Taxonomy has provision for the classification of salt affected soils in the sub-order Salids and also at subgroups level of Cambids. In the salt affected soils of Luni basin the profile distribution of soluble salts is irregular and undergoes seasonal changes. This does not meet the criterion that the salic horizon is a horizon of salt accumulation and, therefore, these can not be classified as Salids. The suborders Cambids, Calcids, Gypsid and Durids have provision for sodicity, but not for salinity.

Therefore, these salt affected soils do not find place in above suborders. In view of this, we suggest the creation of a subgroup, salic, in the suborders Cambids and Calcids of soil taxonomy for saline soils ($E_{c_e} 4-20 \text{ dS m}^{-1}$), as has been done for the sodic soils.

Problem of Petrogypsid and Petrocalcids: Strongly developed and indurated nodular calcrete, or a gypsum pan, dominates the soils of a large area in arid Ra-

Table 1. Taxonomic composition and extent of various mapping units

Map Symbol	Mapping unit (Association of soil families)	Extent	
		km ²	%
1.	Psammentic Haplocambids	1132	0.57
2.	Psammentic Haplocambids, Coarse loamy Typic Haplocambids, Coarse/fine loamy salic Haplocambids, Coarse/fine loamy Calcic, Haplosalids, Torripsamment-P	1680	0.85
3.	Psammentic Haplocambids, Torripsamments-P, (Torripsamments-D)	2312	1.18
4.	Psammentic Haplocambids, Torripsamments-P, (Torripsamments-D) (Coarse loamy Typic Haplocambids, R)	13116	6.66
5.	Psammentic Haplocambids, Torripsamments-P, Torripsamments-D (Coarse loamy Typic Haplocambids)	28656	14.59
6.	Psammentic Haplocambids, Lithic Torripsamments-P, Coarse loamy/sandy Typic Haplocalcids, Torripsamments-D, R	9040	4.60
7.	Coarse loamy Typic Haplocambids, Psammentic Haplocambids, Coarse/fine loamy Fluventic Haplocambids (Torripsamments-D)	8398	4.27
8.	Coarse loamy Typic Haplocambids, Psammentic Haplocambids, Coarse/fine loamy Fluventic Haplocambids (Torripsamments-D, Coarse loamy Typic Calcigypsids)	6120	3.11
9.	Coarse loamy Typic Haplocambids, (Coarse/fine loamy Salic Haplocambids, Coarse/fine loamy Calcic Haplosalids	760	0.39
10.	Coarse loamy Typic Haplocambids, Psammentic Haplocambids, (R)	4640	2.36
11.	Coarse loamy Typic Haplocambids, Coarse loamy Lithic Haplocambids, R	1276	0.65
12.	Fine loamy Typic Haplocambids	1460	0.74
13.	Fine loamy Typic Haplocambids, Coarse loamy Typic Haplocambids (Torripsamments-P)	400	0.20
14.	Fine loamy Typic Haplocambids, Coarse loamy Lithic Haplocambids, R	2790	1.42
15.	Fine loamy Typic Haplocambids, Fine loamy Typic Haplocalcids, Fine loamy Salic Haplocambids, Coarse/fine loamy Calcic Haplosalids	3856	1.96
16.	Fine loamy Fluventic Aquicambids, Fine Typic Aquicambids (Fine loamy/coarse loamy Salic Haplocambids)	1560	0.79
17.	Coarse loamy Typic Haplocalcids, R	5732	2.91
18.	Fine loamy Typic Haplocalcids, Fine Typic Haplocalcids	1340	0.68
19.	Fine loamy Salic Haplocalcids, Fine Typic Haplocalcids, R	1628	0.83
20.	Coarse loamy Calcic Petrogypsids, Coarse loamy Typic Calcigypsids	620	0.32
21.	Sandy Typic Calcids, Coarse loamy Lithic Haplocalcids, R	7340	3.73
22.	Fine loamy calcic Haplosalids, Fine loamy Salic Fluventic Haplocalcids	760	0.39
23.	Torripsamment-D, Torripsamment-P, Psammentic Haplocambids, Sandy/Coarse loamy Typic Haplocalcids (Coarse loamy Typic Calcigypsids)	78542	39.98
24.	Torripsamments-D, Torripsamments-P, R	1440	0.73
25.	Torripsamments-D, Psammentic Haplocambids, (R)	604	0.31

contd..

contd... Table 1

Map Symbol	Mapping unit (Association of soil families)	Extent	
		km ²	%
26.	Torripsamments-D, Coarse/fine loamy Fluventic Haplocambids, Coarse/fine loamy Fluventic Salic Haplocambids, (Fine loamy Calcic Haplosalids, Coarse loamy Typic Calcigypsid)	2807	1.43
27.	Torripsamments-P, Torripsamments-D	4509	2.30
28.	Sandy Typic Torrifluvent	1120	0.57
29.	R, Coarse loamy Lithic Haplocambids	1422	0.72
30.	R, Coarse loamy Typic Haplocalcids, Psammentic Lithic Haplocambids (Torripsamments-P, Coarse/fine loamy Fluventic Haplocambids)	1620	0.83

All family names carry the qualifier mixed hypethermic.

The taxonomic units within parenthesis occupy less than 10% area of the mapping units. Suffix D and P to Torripsamments stands for dunes and hummocky plains, respectively; R signifies rock exposures or hills.

Rajasthan. The overlying solum is so thin that it could have supplied only a small fraction of the huge amount of the salts present underneath. It seems that the source is more of geologic nature, than an illuvial accumulation. However, for want of adequate provision for such situation, the soils have been designated purely by their morphology and not by genetic considerations.

Soil map

The soil map (Fig. 1) and the list of mapping units (Table 1) show thirty mapping units all of which, except the first one, are association of two or more families. The most extensive is unit 23 which occupies 78542 sq. km or 39.98% of the total area. It consists of Torripsamments associated with high dunes and hummocky sandy plains. This unit has patches of soils with profile development, sufficient to qualify as Psammentic Haplocambids. In the accumulative depressions and interdunes the sediments are charged with lime as well as gypsum. The profile shows evidence of partial redistribution of lime and gypsum with a zone of maximum concentration

at 40 to 80 cm depth. These soils quality as Calcigypsid. However, the area occupied by this soil is only 1 to 2%. Unit 5, the second largest (28656 sq. km), is dominated by Psammentic Haplocambids of sandy plains. Of the remaining 28 mapping units, 16 have a coverage of less than 1% and 11 lie in the range of 1 to 5% each.

Extent of individual taxonomic units

In most cases the mapping units are an association of two or more soil families. A single taxonomic unit occurs in several mapping units as a dominant or a subordinate component. Therefore, it is difficult to estimate the areas occupied by individual taxonomic units. An effort has been made here to derive this useful information with some degree of accuracy from the relative occurrence of individual members within the association (Table 2).

At the soil order level, Aridisols and Entisols cover 41.05% and 51.84% area, respectively. Of the several suborders in Aridisols, four are represented in Rajasthan, namely, Cambids, Calcids, Gypsid and Salids, but the first two suborders are most

Table 2. Areal extent of taxonomic units

Sub order	Great group	Sub group	Family	Area			
				km ²	% of total		
Order: Aridisols (78901 km², 41.05%)							
Cambids (60554 km ² , 30.83%)	Haplocambids	Typic	Coarse loamy	18,800	9.57		
			Fine loamy	7,422	3.78		
		Lithic	Coarse loamy	752	0.38		
			Psammentic	–	29,980	15.26	
		Psammentic	–	244	0.12		
		Lithic Salic	Coarse loamy	325	0.17		
			Fine loamy	827	0.42		
		Salic Fluventic	Coarse loamy	180	0.09		
			Fine loamy	235	0.12		
		Fluventic	Coarse loamy	325	0.17		
			Fine loamy	260	0.13		
		Aquicambids	Typic	Fine	524	0.27	
				Fluventic	Fine loamy	680	0.35
		Calcids (18347 km ² , 9.34%)	Haplocalcids	Typic	Sandy	1,824	0.93
					Coarse loamy	5,392	2.74
					Fine loamy	1,608	0.82
Fine	371				0.19		
Lithic	Coarse loamy			244	0.13		
	Salic			Fine loamy	1,511	0.77	
Salic, Fluventic	Fine loamy			382	0.19		
Petrocalcids	Typic			Sandy	3,855	1.96	
				Coarse loamy	3,160	1.61	
Gypsid (845 km ² , 0.43%)	Calcigypsid			Typic	Coarse loamy	467	0.24
		Petrogypsid	Calcic		378	0.19	
Salids (890 km ² , 0.45%)	Haplosalids	Calcic	Coarse loamy	410	0.21		
			Fine loamy	480	0.24		
Order: Entisols (99977 km², 51.84%)							
Psamments (99747 km ² , 51.72%)	Torripsamments	Typic	*Dune	67,341	34.28		
			*Plain	31,106	16.34		
		Lithic		2,160	1.10		
Fluvents (230 km ² , 0.12%)	Torrifluvents	Typic	Sandy	230	1.12		

* Not family name but soil scape name.

extensive. Amongst the Cambids, the great group Haplocambids with seven subgroup is most extensive. The newly proposed subgroup Psammentic Haplocambids covers half of the total area of all the Haplocambids:

Calcids are mainly composed of Haplocalcids and Petrocalcids.

The Entisols are represented mainly by Torripsamment great group. Within this the

Table 3. Extent of Aridisols and other miscellaneous lands

Arid soils/miscellaneous lands	Area	
	km ²	%
Arid soils	1,82,473	92.89
Skeletal soils	8,130	4.13
Major saline depressions	660	0.34
River coarse and ravinous lands	430	0.22
Rocky pediments	487	0.25
Hills	4,260	2.16

dune phase occupies 67,341 sq. km (34.28%) and the hummocky plains 32106 sq. km (16.34%). The extent of Aridisols and other miscellaneous soils are reported in Table 3.

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