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CHARACTERISTICS OF THE SHORT DISTANCE TRANSPORTED FLUVIAL SEDIMENTS IN AN ARID ENVIRONMENT

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ABSTRACT

Characteristics of the short distance transported sediments in an arid environment have been studied. Sediment derived from the sandy plain, dune complex and rocky gravelly catchments contained more clay and silt than the matrix soil. The sand fraction of these sediments, dominated by poorly sorted finer grade, showed narrower size range than the soil proper indicating restricted velocity fluctuation during sedimentation.

INTRODUCTION

Aeolian sediments have drawn attention of many workers (Goudie, 1978; Vincent, 1984; Khalaf and Al-Hashash, 1983; Behary et al., 1985). Due to low rainfall, fluvial sediments are only localised, but they assume significance when regular sedimentation reduces the life span of structures designed to harvest rain water (Jones, 1981; Sharma and Chatterji, 1982; Sharma and Joshi, 1982). The characteristics of the fluvial sediments are directly related to the catchment attributes, particularly the type of soil.

In the Indian desert 'khadins' (Kolarkar et al., 1983) and 'nadis' (Sharma and Joshi, 1981) are the principal water storage systems. The 'nadis' seldom overflow and provide the excellent sites for the study of fluvial sedimentation processes. Grain size parameters have been used to separate the beach, dune, aeolian and fluvial sedimentation (Folk and Ward, 1957; Mason and Folk, 1958; Friedman, 1961). Present study is intended to describe the composition and characteristics of the short distance (< 100 m) transported fluvial sediments and to relate these with their environment.

STUDY AREA

The study was carried out in the Nagaur district of Rajasthan between 24°6 to 26°0 'N latitude and 73°1' to 75°4 'E longitude. The northern and north-western part of the district is covered with dune complex and sandy plains, while southern part is medium and fine textured alluvial plain. Steeply rising hills occur at the south-eastern fringe and the rocky/gravelly pediments are scattered throughout the area but more commonly in the south-western part. Average annual rainfall for the last 80 years is 384 mm – about 80% of which is received between June and September.

MATERIAL AND METHODS

Sediment samples were collected from the beds of the small 'nadis' or earthen dug out/embankment ponds with catchment areas < 5 km^2. The sampling sites were selected by stratified random sampling technique representing the physiographie regions-sandy plain (Chirai, Bher, Kumparabas, Molasar and Jayal soils), duny complex (dune, Molasar hummocky and Molasar highly hummocky soils), medium and fine textured alluvial plain (Asop, Khajwan, Panchroli, Parbatsar and Palari pichkia soils) and rocky/gravelly pediments. The samples were collected during the dry months when these ponds did not contain water. Soils, from the respective catchments, were classified as per the standard soil survey carried out for the district (Dhir et al., 1979). Both the sediments and soil samples were analysed for primary particle composition (Piper, 1950). The sand fraction was shaken for ten minutes through a nest of sieves and separated in different grades (Griffith, 1967). Each fraction was weighed and reported as percentage. Particle size data were converted from mm to Φ scale and presented as frequency curves. Through cumulative frequency curves the diameter of sand fractions at 25 (Q_1), 75 (Q_3), 90 (P_{90}) and 10 (P_{10}) percentiles and median diameter (Md) at 50 percentile were calculated. The parameters of graia size distribution such as sorting coefficient (S_o), Skewness (S_k) and quartile kurtosis (k) were calculated by using the following formulae (Twenhofel and Tyler, 1941).

$$S_o = \frac{Q_3}{Q_1}, \; S_k = \frac{Q_1 Q_3}{md^2}, \; K = \frac{Q_3 - Q_1}{2(P_{90} - P_{10})}$$

RESULTS AND DISCUSSION

The sediments, generated by torrential rainfall and after transported to a short distance (50 to 100 m) through runoff by saltation as well as surface creep, get deposited in the ponds. Morphological characteristics and mechanical composition of the catchment soils and respective sediments have been reported earlier (Sharma and Joshi 1982). Relationships between sand fractions of the soils and sediments are discussed:

Sandy plain

The soils contained 3 to 8% silt and 8 to 12% clay. The sand fractions of these soils showed bimodal distribution, with primary mode at 2. 5 to 3. 2 Φ, the secondary mode at 3. 8 to 5. 6 Φ (Fig. 1) and the median diameter varying from 0.117 to 0. 154 mm. The sand fraction of these soils was well sorted and skewed towards finer grade. The kurtosis values were in narrow range (Table 1).

In comparison with soils, the sediments contained higher amounts of silt (4 to 20%) and clay (10 to 34%). The sand fraction showed bimodal distribution with the primary mode to 3. 8 to 5. 6 ϕ and secondary mode at 2. 0 to 3. 0 ϕ. About 80% grains were distributed in two grades. The median diameter had a range of 0. 038 to

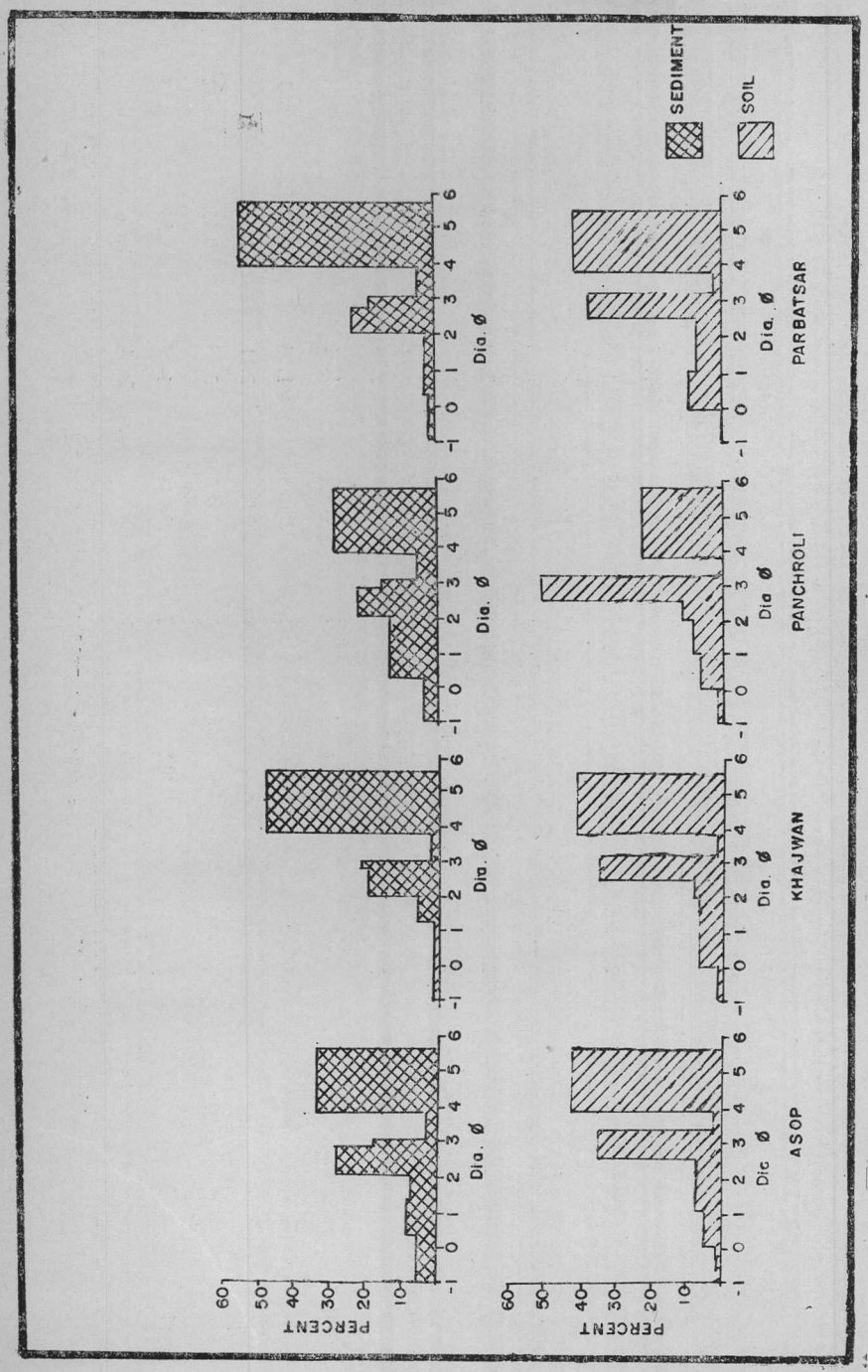

Fig. 1. Frequency distribution of sand fractions in soils and sediments derived in the sandy plain.

Table 1. Sedimentary characteristics of catchment soils and 'Nadi' sediments in sandy plain areas

Soil series		Rainfall zone (mm)	Sedimentary characteristics					
			Md (mm)	Q_{25} (mm)	Q_{75} (mm)	S_o	S_k	Kurtosis
Chirai	Soil	—	0.154	0.165	0.109	1.23	0.76	0.08
	Sediment	250-300	0.125	0.145	0.038	1.95	0.35	0.33
	Sediment	300-350	0.068	0.145	0.031	2.16	0.97	0.29
Bher	Soil	—	0.140	0.165	0.109	1.22	1.00	0.13
	Sediment	250-300	0.124	0.200	0.037	2.32	0.48	0.17
	Sediment	300-350	0.115	0.145	0.044	1.82	0.48	0.31
Kumparabas	Soil	—	0.134	0.165	0.109	1.23	1.00	0.13
	Sediment	350-400	0.105	0.160	0.038	2.05	0.55	0.25
Molasar	Soil	—	0.117	0.144	0.072	1.41	0.76	0.26
normal	Sediment	300-350	0.038	0.100	0.026	1.96	1.80	0.33
	Sediment	350-400	0.046	0.125	0.028	2.11	1.65	0.37
	Sediment	400-450	0.125	0.180	0.037	2.45	0.43	0.32
Jayal	Soil	—	0.117	0.165	0.044	1.93	0.53	0.18
	Sediment	350-400	0.054	0.145	0.031	2.16	1.54	0.20

maximum sorting from the median diameter (Mason and Folk, 1958). The sand fraction in sediments from the duny complex unit were sorted towards finer grade of the median diameter (skewness > 1); while in sandy plain, medium and fine textured alluvial plain and rocky gravelly pediments it was sorted towards coarser side of the median diameter (skewness < 1).

Kurtosis less than unity indicates restricted velocity fluctuations during the sedimentation (Sahu, 1964). In the present study, the Kurtosis values were always less than unity and indicated a narrow size range of soils and sediments among the studied environments.

These studies revealed that the sediments derived in different environments have variable amount of silt and clay. As regards sand, these are dominated by the finer fractions. A narrow range in the kurtosis and sorting coefficient values suggest that the sediment suit belong to the same population and evidently is a product of the similar processes (Visher, 1969). The dominance of finer grade of sand in different environment can be attributed to its ubiquitous presence.

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