

SOIL DEGRADATION STUDIES UNDER DIFFERENT LAND USE SYSTEM IN AN ARID ENVIRONMENT

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ABSTRACT

Local (micro level) soil degradation processes going on in Jhanwar and Doli villages of Jodhpur district in different land use systems have been studied. The cultivation on marginal land accelerate the wind erosion and the use of poor quality irrigation water is creating sodicity problem in soil resulting in severe degradation. Pasture land has been completely degraded due to over exploitation of the vegetation resulting in severe wind and water erosion. However, the land under *oran** have suffered the least degradation. Influence of degradation on fertility status of soils has been observed.

INTRODUCTION

Deserts are extremely sensitive to any disturbance within the ecosystem, whatever be the cause natural or anthropogenic. Both increased aridity and irrational use and over exploitation of natural resources bring about degradation of vegetation, soils and water and pave way for the processes of desertification.

Some studies on land degradation mapping on small scale using remote sensing techniques have been reported (Raina et al. 1991) but characterization of degradation processes at micro level (village) which are the actual operational units, has not been taken up. Present study is an attempt to find out the impact of micro level studies on various degradation processes, under different land use system in Jhanwar and Doli villages of Jodhpur district with a view to help developmental programmes to restore productivity of land.

MATERIAL AND METHODS

Study area: Total geographical area of two villages is 9938 ha (Doli 2340 ha, Jhanwar 7597 ha). Doli village extends from 26°08'38" to 26°12'16" N and 72°5'57" to 72°55'09" E and Jhanwar village extends from 25°19' N to 25°13'45" N and 72°45'00" E to 72°53'26" E longitude, located 23 km south west of Jodhpur. The climate is arid with low and erratic rainfall. Natural vegetation mainly consists of *Capparis decidua*, *Prosopis cineraria*, *Tephrosia pyrotechnica* and *Calotropis procera*.

* Oran land being used only for animal grazing and cutting of trees is religiously prohibited.

Cadastral maps (1:10,000) were used as the base map. The kind of soil degradation process namely wind erosion, water erosion, salinisation etc. on cultivated, pasture and irrigated land were identified and extent determined. Soil samples were collected from rainfed cultivated, irrigated and pasture lands from degraded and non-degraded sites for fertility analysis. Soil samples were also collected from the sites where fresh sand deposition/erosion were observed in cultivated fields. Soil and water samples were collected from the irrigated fields to see the effect of high RSC water on the soil. Soil samples were analysed for organic carbon, available phosphorus and available potassium by standard procedures (Jackson 1967).

RESULTS AND DISCUSSION

Degradation in Grazing and oran lands

Continuously increasing pressure of animal population and erratic rainfall have resulted in the disappearance of perennial and annual grass species from the grazing land of Doli and Jhanwar villages and these have been substituted by partially palatable and non-palatable species. Few annual grass species viz. *Aristida funiculata* and *Cenchrus biflorus* are present which formed negligible biomass. Animal browsing is less detrimental for shrubs and trees than lopping, specially all round cutting, resulted in complete destruction of shrubs and trees. On sandy terrain exploitation of vegetation by unrestricted grazing and cutting trees and shrubs for firewood resulted in acceleration of sand movement. Due to high wind velocity soil erosion takes place. Total area of pasture land in Jhanwar and Doli villages is 5.05 and 7.1% respectively, which is highly degraded due to wind erosion and water erosion activities.

(a) Wind erosion : Grazing land of Jhanwar village was in highly degraded condition due to the deposition of about 1 feet sand sheeting and hummocks, as the result of severe erosion and deposition. *Capparis decidua*, *Tephrosia* sp. and *Prosopis juliflora* are present in highly degraded condition.

(b) Water erosion : Water erosion has caused intricate rills and gullies formation at places. In south western part of Doli village, oran land adjoining to the settlement is affected by water erosion (Compact surface soil resulted in high runoff, moderate to severe soil erosion) forming small rills and gullies.

Degradation on rainfed cultivated lands

Rainfed cultivated lands are mainly affected by wind erosion and water erosion activities. Total cultivated area in Jhanwar is 82% but only 50-60% of this is regularly cultivated.

(a) Wind erosion : Wind erosion is very active on rainfed cultivated land and principal process of soil degradation. Out of total cultivated area (6230 ha) 23% area (1433 ha) is not suitable for cultivation due to marginal lands (sand dunes). The land after harvest of crop remains fallow for 6-8 months every year which is subjected to severe erosion due to high wind velocity. The dunes occurs in the north western part of the village and near Rason Ki Dhani. Due to cultivation on the slopes of the dunes, overgrazing and lopping of trees, the crest and flanks have been reactivated, resulting in fresh sand deposition on the adjoining cultivated fields. Nearly 44% of the cultivated land is under different stages of degradation. Slight and moderate erosion occurs in the south western part of the village. The surface soil has degraded due to sand sheeting and the formation of hummocks and stabilized dunes. Thus, only 15% of cultivated land is without any aeolian activity and occurs in the north of Jhanwar village, along the southern boundary of Rohilla Kalan and southern boundary of Khundala villages.

Total cultivated area in Doli is 1449 ha out of which 27.5% (398 ha) area is under cultivation on marginal lands which occurs in the eastern part of the village. In this village only 9.4% area is free of aeolian hazards. 52.5% area is suffering from aeolian activities. Cultivated land highly degraded due to wind erosion occupied 27.5% area. The farmers experience has been that the crop yield in severely eroded lands is half to one third of that from an uneroded field.

(b) Water erosion : In Jhanwar village due to human interference with the natural flow of the nallahs their beds have been aggraded and rainwater overflows which has dissected the plain into rills and gullies. As a result some cultivated fields (1% area) are facing problem of water erosion located in the north-east and north west of the village. In Doli village along the Golasni river some parts are degraded due to water erosion.

Degradation in the irrigated land

Disregarding the aridity of region and lack of sufficient rainfall to recharge the ground water, farmers deepen their well and use powerful pumps to exploit water. Over exploitation of water has resulted in deterioration of the water quality and quantity in many wells of the two villages. Many wells of Jhanwar and Doli village have gone dry. Earlier water for irrigation was lifted through engines/motors by only 4% of farmers but now it has increased to 24% farmers. As a result of irrigation with high RSC water (Table 1) the pH of the soil increased upto 9.8 and soils have become compact, and hard and due to this infiltration rate has greatly reduced. At places the land has degraded to such an extent that the fields have been abandoned. After irrigation soil have degraded to such an extent that even rainfed cropping is not possible. 420 ha (5.53%) land in Jhanwar out of 512 ha (6.74% area) and 428 ha (18.3% area) out of 636 ha (27.2% area) land in Doli village has degraded due to

irrigation with saline sodic water. Only 1.21% area in Jlanwar and 8.9% area in Doli is under good quality water irrigation. The soil degraded due to irrigation with high RSC water could be improved by application of gypsum. The grain yield of Raya and wheat crops could be increased significantly due to application of gypsum (Joshi and Dhir 1989; 1990).

Table 1. Influence of irrigation with high RSC water on soil characteristics

Site No.	Water quality				Soil characteristics	
	pH	EC (dSm ⁻¹)	RSC (me L ⁻¹)	SAR	pH ₂	EC ₂ (dSm ⁻¹)
1	8.8	2.65	12.9	22.9	9.2	0.62
2	8.6	1.58	12.9	31.3	9.4	0.78
3	8.4	1.66	13.2	17.85	9.9	0.67
4	9.1	4.70	24.1	25.90	9.5	0.66
5	8.7	2.09	14.2	25.80	9.4	0.62

Soil degradation and fertility status

Fertility status of degraded and associated non-degraded sites, under different landuse are reported in Table 2. Degraded soils of cultivated, pasture and oran lands contained less amount of nutrients. Soils of oran land contained comparatively higher amounts of nutrients because of better vegetation cover and less biotic interference. Cultivation on marginal lands has resulted in severe depletion of the nutrients because of greater soil loss through severe wind erosion/deposition process.

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Table 2. Effect of soil degradation on fertility status of soil under different land use

Nutrients	Cultivated land		Pasture land		Oran land		Fresh sand deposition	Eroded soil
	Degraded	Non-degraded	Degraded	Non-degraded	Degraded	Non-degraded		
Organic C (%)	0.14-0.26 (0.19)	0.08-0.11 (0.09)	0.09-0.15 (0.12)	0.16-0.27 (0.20)	0.10-0.11 (0.10)	0.12-0.49 (0.31)	0.07-0.15 (0.10)	0.02-0.04 (0.02)
Available P (ppm)	1.1-6.6 (3.6)	2.0-3.9 (2.8)	3.9-4.7 (4.1)	2.0-13.7 (6.4)	2.0-4.7 (2.35)	4.7-11.5 (9.6)	2.6-9.6 (5.0)	1.1-4.0 (2.0)
Available P (ppm)	50-220 (114.4)	50-115 (80)	90-197 (120)	65-120 (93.7)	90-197 (145)	172-357 (266)	51-135 (87)	60-82 (80)