

Identification and Mapping of Wastelands in Tonk District, Rajasthan, Using Remote Sensing and their Management Options

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Abstract : Seven types of wastelands were identified and mapped through visual interpretation of Landsat TM FCCs of semi-arid Tonk district in Rajasthan. Wastelands in the district cover 21.04% area, of which the maximum was under degraded grazinglands (45.24%). The status of degradation of these wastelands were verified from field. The reclamation options, including soil and water conservation measures, as well as plantation of suitable species, were also worked out.

Key words : Wastelands, mapping, reclamation, remote sensing.

Problems of wastelands and their management assume complex proportions in view of the fact that while their present production is much lower than the potential, the wastelands are also being constantly overutilized. Overutilization of land not only degrades and destroys its production potential, but also increases the spatial extent of wasteland in it (Shankarnarayan *et al.*, 1982). Since both the processes are operative continuously in an area, base line information on wasteland types and their extent is essential to prioritise the development of sensitive wastelands as well as to monitor changes in their extent. Such information has been successfully generated using remote sensing data by a large number of workers (Mouat *et al.*, 1980; Sharma *et al.*, 1989; Singh *et al.*, 1990). The present article reports findings of one such study in the semi-arid Tonk district of Rajasthan, using remote sensing techniques, and suggest, their possible management options.

Tonk District (75°7'E to 76°19'E and 25°41' N to 26°34'N) covering 7194 sq. km area is characterised by an undulating terrain with hills of Aravalli system. The climate is generally dry except during the short southwest monsoon season (mid-June to mid-September) and is of semi-arid type. A total of 615 mm annual rainfall is received in 33 rainy days, the maximum being in July (212 mm), followed by that in August (207 mm) and September (94.4 mm). Between April and

October the temperature ranges from 26° to 40°C, but often touches 46°C, while in winter (November-March) it varies from 8° to 22°C.

The Banas and its tributaries are the notable streams which flow over the peneplane. The major perennial river is the Banas, with the Mashi as its tributary. The hills with an altitude of 409 to 605 m, belong to the Aravalli and the Delhi systems. The general slope of the region is from northwest to southeast. Ground water occurs at 9 to 18 m depth, and is sweet in all the tehsils except in a few pockets of Toda Rai Singh and Niwai.

Materials and Methods

Landsat TM False Colour Composites (FCCs) generated by a combination of bands 2, 3 and 4 on 1:50,000 scale were oriented with the help of Survey of India topographical maps of 1:50,000 scale. Different wasteland units were then interpreted and identified using a standard guide on tone, texture, shape, size, colour and associated features (NRSA, 1986), and were transferred onto the base maps. These units were also verified during reconnaissance field traverses and corrected wherever it was found necessary. In the final map, area under different categories of wastelands was calculated using a millimetre grid polythene graph sheet on the master map.

Results and Discussion

Wasteland types and their extent

Seven types of wastelands were identified following NRSA (1986) nomenclature : a) gullies and ravinous lands, b) undulating uplands with or without scrub, c) saline and alkaline wastes, d) degraded pastures and grazinglands, e) degraded forest lands, f) sands, and g) barren, rocky, stony wastes.

A total of 21.04% area of the district is under these wastelands (Table 1). Degraded pastures/grazinglands occupy nearly half (45.24%) of the total wasteland area (Table 1). This is followed by degraded forests, saline and alkaline lands, gullied and ravinous lands, undulating uplands, sands and barren rocks.

Table 1. Area and percentage to total of each category of wasteland in Tonk district

Category	Area of wasteland (sq. km)	Total geographical area (%)	Total wasteland (%)
Gullied and or ravinous land	197.81	2.75	13.06
Undulating upland with or without scrub	80.97	1.12	5.34
Land affected by salinity/alkalinity	210.71	2.93	13.91
Degraded pastures/grazing land	685.07	9.52	45.24
Degraded forest land	241.01	3.35	15.92
Sand	76.37	1.06	5.04
Barren rocky/stony waste	22.52	0.31	1.49
Total	1514.46	21.04	100.00

Spatial distribution and characteristics of wastelands

Gullied and ravinous land : On the FCCs, two types of gullies, deep and shallow, were identified. The deep gullies appear in light blue to light brown with deep blue streaks, while the shallower ones appear in dull brown to reddish and brown with light blue streaks. These occur mostly in the northeastern part of the district, especially in Niwai and Malpura tehsils (Fig. 1). Many are 60 cm to 8-9 m wide and 1-5 m deep, originating mostly in the degraded grazing lands and then advancing into the cultivated fields where large area is now engulfed by these gullies. Soil is more than 1 m deep, sandy to sandy loam with pale brown to dark yellow in colour.

Vegetation cover is poor and has predominance of *Cynodon dactylon* and *Desmostachya bipinnata* grasses and *Butea monosperma* and *Phoenix dactylifera* trees. The other type of shallow gullies are in the uplands where soil is 6 to 18 cm deep, sandy loam to loam and yellowish brown to reddish brown over the weathered gravel stratum. They have poor scrub vegetation, mainly *Prosopis juliflora*.

Undulating upland with or without scrub : These uplands appear as light grey on TM FCCs. Uplands without scrub are the undulating, rocky/gravelly areas with small rills and non-saline sandy to sand or loam soil of shallow depth (3-10 cm), supporting a sparse cover of highly degraded *Ziziphus nummularia* with no grasses and trees. These appear as whitish grey to light grey on

the FCCs. Uplands with scrubs are also the undulating, moderately eroded, rocky/gravelly surfaces, but have deeper soil (20-30 cm), mainly sandy loam to sandy clay loam of yellowish brown to reddish brown colour. Scrubby vegetation consists of *Prosopis juliflora*, *Acacia nilotica* and *Ziziphus nummularia*.

Saline and alkaline wastes : These appear on the FCCs as light blue with milky white patches. Saline and alkali wastelands are predominant in the northwest, mainly in the tehsil of Malpura, Toda Rai Singh and Devli. Three types of saline wastelands could be recognised. Some patches of land are naturally saline due to their low lying position. The second type occurs due to irrigation with saline water. The third type is

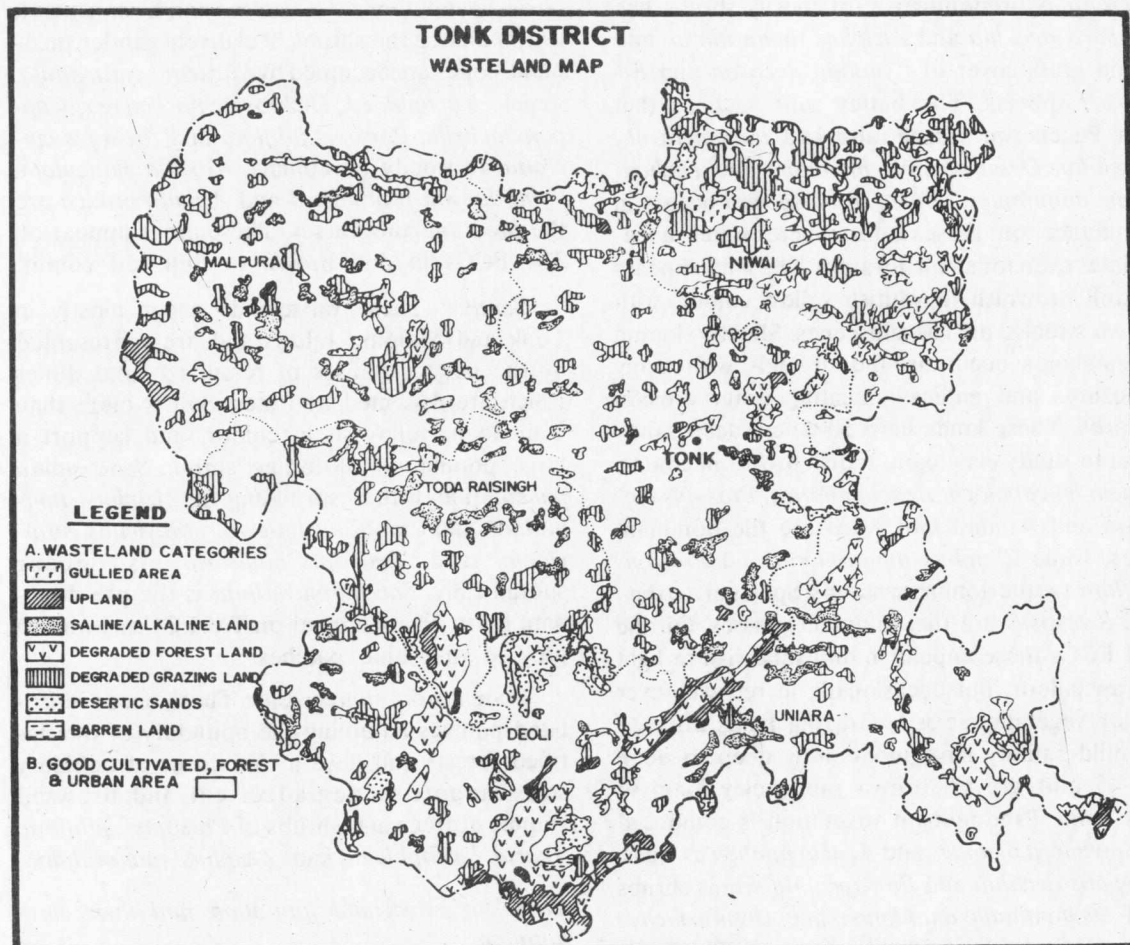


Fig. 1. Wasteland map of Tonk district

the gullied land where run off accumulates and evaporates, leaving salts on the surface. The first type occurs in village grazing lands, where soil is 5-15 cm thick, reddish brown to greyish brown in colour, sandy loamy to sandy clay loam and is mildly saline. These appear as light blue to dull white patches on the TM FCCs. They support *Prosopis juliflora* scrub, punctuated with occasional *Capparis decidua* and *Salvadora oleoides* trees and grasses like *Cynodon dactylon* and *Dichanthium annulatum*. The second type is mainly in the canal irrigated areas where the soil is 45-90 cm deep, sandy clay loam to clay loam and grey to greyish brown in colour. These lands have healthy trees of *Acacia nilotica* and *Phoenix*

dactylifera and shrubs of *Prosopis juliflora*. The third type on the wide gully floors, have 50 cm deep sandy loam to sandy clay loam soil, greyish brown to greyish in colour.

Degraded pastures and grazing lands : These wastelands occur in grazing lands around each village of the district. A majority of these are sandy undulating plains. The other two habitats are the sloping uplands and the slightly salt-affected lands. All these face moderate to severe water and wind erosion hazards. Grazing lands on sandy plains have deep to very deep sandy soil of yellowish to reddish brown colour, supporting a few trees of *Acacia nilotica* and *Prosopis*

cineraria, a predominance of thorny shrubs like *Capparis decidua* and *Ziziphus nummularia*, and a thin grass cover of *Cynodon dactylon* and *Eragrostis* species. The better soils such as that near Pacchewar village, also had *Indigofera oblongifolia*, *Desmostachya bipinnata* and *Dichanthium annulatum*. *Butea monosperma* occurs in abundance on these lands where water accumulates even for small duration. The land appears as dull brownish to whitish yellow colour, with brown streaks, on TM subscenes. Slightly sloping grazing lands occur around uplands with stony exposures and gullies indicating water erosion hazards. These lands have 50-90 cm deep sandy loam to sandy clay loam, redish brown in colour. *Acacia leucophloea*, *Acacia nilotica*, *Prosopis cineraria* and *Azadirachta indica* are the dominant trees, while *Ziziphus nummularia* and *Prosopis juliflora* are the dominant shrubs. Species of *Aristida* and *Eragrostis* are the dominant grasses. On the TM FCCs these appear in dull yellowish to light brown colour, but occasionally in red wherever better vegetation exists. Grazing lands affected by mild salinity have moderately deep to deep (25-45 cm) greyish brown sandy clay loam to clay loam. Predominant vegetation is composed of *Salvadora oleoides* and *Acacia nilotica* as trees, *Capparis decidua* and *Prosopis juliflora* as shrubs and *Dichanthium annulatum* and *Desmostachya bipinnata* as grasses. Their images on TM FCCs appear as dull brown to dull yellowish or whitish yellow with bluish spots. Vegetation in all these types of grazing lands is moderate to severely degraded, overgrazed and have wind and water erosion hazards.

Degraded forest lands : Degraded forests occur on hills and piedmonts with gullies and shallow to moderately deep (3-25 cm) sandy loam soils near Niwai, Malpura, Uniara and Tonk towns. They support a mixed stand of *Anogeissus pendula* - *Boswellia serrata* on higher elevations and *Anogeissus pendula* - *Acacia senegal* on lower elevations. Other commonly occurring plants in these forests are: *Acacia catechu*, *Wrightia tinctoria* and *Dendrocalamus strictus* amongst the trees and

Grewia tenax, *Grewia flavescens* and *Commiphora wightii* among the shrubs. Relatively gentler piedmont slopes are occupied by *Maytenus emarginata*, *Acacia leucophloea*, *Dichrostachys cinerea*, *Capparis aphylla*, *Prosopis juliflora* and *Prosopis cineraria* as woody perennials. *Aristida funiculata*, *Cymbopogon jwarancusa* and *Apluda mutica* are the predominant grasses. These areas appear on TM FCCs in dull brown to dull red colour.

Sands : These wastelands occur mostly in Tonk and Malpura tehsils and are represented by the large expanses of fossilized sand dunes which are dissected by water. Soil is more than 1 m deep, yellowish in colour, and support a large population of forage shrub, *Sericostoma pauciflorum* with a sprinkling of *Ziziphus nummularia* and *Calotropis procera*. *Maytenus emarginata* and *Prosopis cineraria* also occur sporadically. *Saccharum munja* is the pre-dominant grass. These appear on TM FCCs as whitish grey to dull blue patches.

Barren rocky/stony waste : These occur in isolated patches adjoining the boundary of the notified forests and have a thin cover of bouldary soil, supporting degraded, cut and browsed stumps of trees and shrubs of *Prosopis juliflora*, *Acacia leucophloea* and *Ziziphus nummularia*.

Causes of wasteland formation and their amelioration

Appraisal of wastelands in different landforms and different land uses reveals that in addition to deforestation and excessive grazing the other important factor in the formation of wastelands in Tonk is the rainfall. Torrential rains on the incohesive sandy soils lead to the formation of rills and gullies in the upper reaches, while salinity has developed in the lower parts due to impeded drainage. Ameliorative measures will, therefore, include a broad spectrum of soil conservation strategy including gully plugging, anicut construction and afforestation at suitable sites. Bank cutting is a menace in this region and needs to be stopped through bank stabilization. Salt-affected lands can be put under salt loving crops

or halophytic forage vegetation. In spite of micro site variations, the following plant species can generally be used for wastelands reclamation in the district:

Gullied and ravinous lands : Planting grasses like *Cynodon dactylon* and *Desmostachya bipinnata* on gully floors and trees like *Eucalyptus*, *Phoenix dactylifera*, *Butea monosperma*, *Dichrostachys nutans*, *Ailanthus excelsa* and *Albizia lebbek* on gully sides and edges would stabilise advancing gullies. As soil depth improves *Cenchrus ciliaris* can also be grown.

Undulating uplands : Protection from biotic interference, followed by pit plantation of *Anogeissus pendula*, *Acacia senegal* and *Acacia catechu*, and reseeding with grasses of *Apluda mutica* are the possible ways to reclaim these uplands.

Land affected by salinity/alkalinity : Such lands can have *Acacia nilotica*, *Salvadora oleoides*, *Acacia tortilis* and *Prosopis juliflora*, along with grasses like *Dichanthium annulatum*.

Degraded pastures and grazing lands : These have poor plant species and hence can be planted with *Prosopis cineraria*, *Leucaena leucocephala*, *Dichrostachys nutans*, *Acacia nilotica* and improved strains of *Ziziphus nummularia* amongst the trees and *Cenchrus ciliaris* and *Cynodon dactylon* amongst grasses. *Butea monosperma*, *Ailanthus excelsa* and *Dichanthium annulatum* can be planted along the margins of tanks and where water accumulates.

Degraded forest lands : The suitable species for these areas are *Anogeissus pendula*, *Boswellia serrata*, *Commiphora wightii* and *Dendrocalamus strictus*.

Sands : *Acacia tortilis*, *Prosopis cineraria*, *Saccharum munja*, *Cenchrus ciliaris* and *Dichro-*

stachys nutans are suitable for reclamation of sandy wastelands.

Barren rocky/stony wastes : These deserve complete protection for five years and plantation of *Acacia senegal*.

Conclusion

It has been possible to identify seven different wasteland types in the semi-arid Tonk district using satellite data. This information, coupled with ground information, is helpful in deciding management options, as also found by Tueller (1987) in the arid environments of USA.

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