IRS-1A Applications in Desertification Studies

R. P. DHIR AND J. R. SHARMA

ABSTRACT: *The fragile habitat of our desertic tract is witnessing an accelerated degradation of its natural endowments as a result of over-exploitation. Wind erosion and generation of drift sands, manifested in the degree of stability of land surface and degradation of vegetation cover are the two major desertification processes. The operation of these processes is spatially variable. Besides, the vastness of terrain and its poor trafficability militate against an inventory from ground traversing alone. Results of the study show that IRS-1A data can be a very useful tool in monitoring the incidence of desertification. Amongst the various processings of IRS data attempted, Soil Brightness Index was the best in separating land surfaces of different degrees of stability and incidence of wind erosion. In the case of pasture land cover, NDVI from the Red and the IR bands of IRS data showed potential in assessing degradation of the otherwise sparse vegetation cover.*

INTRODUCTION

The hot desertic tract of India, known in parts as the Thar, Maru, Jangala, Bagar, Shekhawati, Thali and collectively called Marudesa or Marusthali, occupies 0.3 million sq. km or nearly ten per cent of the area of our country. Low rainfall (500 mm to less than 100 mm mean annual precipitation) and its high inter-annual fluctuation (45–60% coefficient of variation), high solar radiation, strong wind regime, very low humidity and a very high atmospheric moisture deficit are the characteristic climatic features of the region. The Marusthali has a long history of human settlement and land use. At present, the desertic tract of Rajasthan alone sustains a population of 17 million, besides nearly 25 million heads of livestock. Whereas the tract with more than 250 mm mean annual rainfall has an opportunistic agriculture as the dominant land use, the more desertic tract has open pasture lands and animal husbandry as the principal activity, except for pockets that have come under irrigation from Indira Gandhi Canal and other projects.

Although, the prevalent life-style, land use and land management in the area are an outstanding example of human adaptation to an inhospitable environment, yet the progressive increase in the biotic pressure over the past several decades has led to an accelerated degradation of the natural endowments. The near collapse of the traditional fallow-farming system or overcultivation, expansion of agricultural activity onto marginally suited lands, overgrazing, cutting of trees and over-draft of ground water are some of the vivid transformations of the mounting pressure. These man-induced changes have interacted with the fragility of the desert ecosystem to set in motion the process of desertification, which has been defined as the destruction of the biological potential of land, leading to intensification or extension of desert conditions[1].

The operation of land degradation processes over the vast area of the region is spatially variable. This consideration together with the poor trafficability of terrain and inadequacy of camping sites, militate against any systematic large scale monitoring from ground traversing.

ASSESSMENT OF INCIDENCE OF SAND DRIFT

The erodible nature of dunes and sandy plains, inadequate management and strong wind regime lead to accelerated soil erosion, and generation and drift of large masses of loose sand, which are not only a menace for the desert dweller, but also a poor habitat for use. In fact, stabilisation of these drift sand features becomes a costly rehabilitation operation. The problem of soil erosion and resultant drifting sands is common to both the cultivated and open pasture lands. The incidence of sand drift is directly correlatable to the stability of land surface. In field situation, one can encounter an entire spectrum of stability expressed in land surfaces, which are fairly stable to those that are entirely unstable. For simplicity, three categories, namely stable, semi-stable and unstable are considered here.

It has been reported that the surface of unstable lands, though not much different in particle size distribution and hue from that of the stable landforms, yet gives a significantly higher reflectance in visible as well as near IR bands[2]. Contrast stretching of RS data in various bands was used for recognition of land-surface of varying degrees of stability. Since vegetation cover was found to disproportionately affect the result, RS data of winter months was used for the purpose. Besides individual band data, Principal Component Analysis and linear band combination, namely Soil Brightness Index (SBI) using the coefficients derived for IRS data by Sharma *et al.*[3] were also attempted. The results are summarised below:

Method	Remarks
Contrast stretching of individual IRS band data	Satisfactory for interference effect of vegetation.
Principal Component	Not satisfactory.
Soil Brightness Index	Good, Vegetation was found least.

Thus, amongst the various methods, SBI was found to be most useful. Distribution of area under the different categories of surface stability, and the statistics based on density sliced (SBI) output from IRS-1A data (December 6, 1990, IRS-1A LISS-II 34–48 B2) are given in figure 1 and table 1.

The results suggest that IRS-1A data enables recognition of land-surfaces of different degrees of stability and incidence of sand drift which in turn can form a basis for a regular monitoring methodology to discern trends over time.

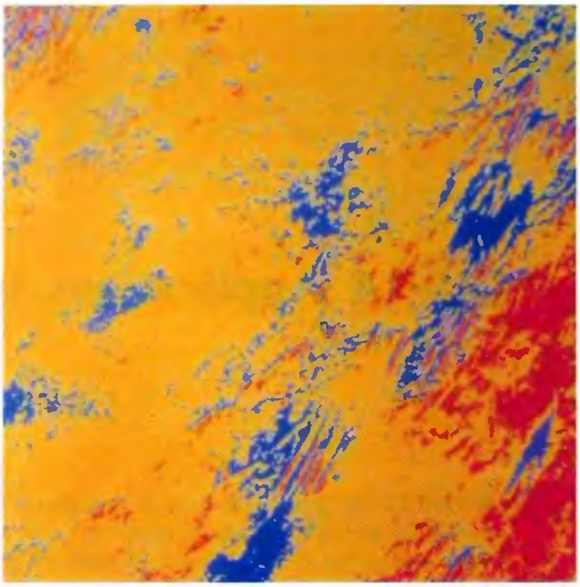

Figure 1. Distribution of land surfaces of different degrees of stability and incidence of sand drift from Soil Brightness Index from IRS-1A data. Stable (blue), semi stable (yellow) and unstable (red).

Table 1. Incidence of sand drift and surface instability from IRS-1A data in an area near Lathi, Jaisalmer

Sand features	Percentage of the total area	Area under each category (hectares)
1. Unstable	11.76	4052.57
2. Semi-stable	68.54	23610.42
3. Stable	19.70	6784.37

PASTURE LAND DEGRADATION

Rainfall in the western half of the region is too low to permit agricultural activity. Therefore, the dominant land use here is only the open pasture lands which sustain a large population of some of the finest breeds of sheep, goat and cattle.

The vegetation cover, however, is sparse and even in the best of situations, it does not exceed 18–20 per cent, though more often the range is 2 to 6 per cent only[4]. Therefore, by far a major contribution to reflectance of pasture lands is from bare soil. The difference in brightness in the visible and the IR bands of good and degraded cover classes is small, yet it was seen that spectral vegetation indices like NDVI and GVI derived from RS data are sensitive enough to enhance subtle differences in vegetation cover and biomass[5]. Besides, these are also less sensitive to the degree of illumination, inherent in a duny landscape[2]. The NDVI output showing cover

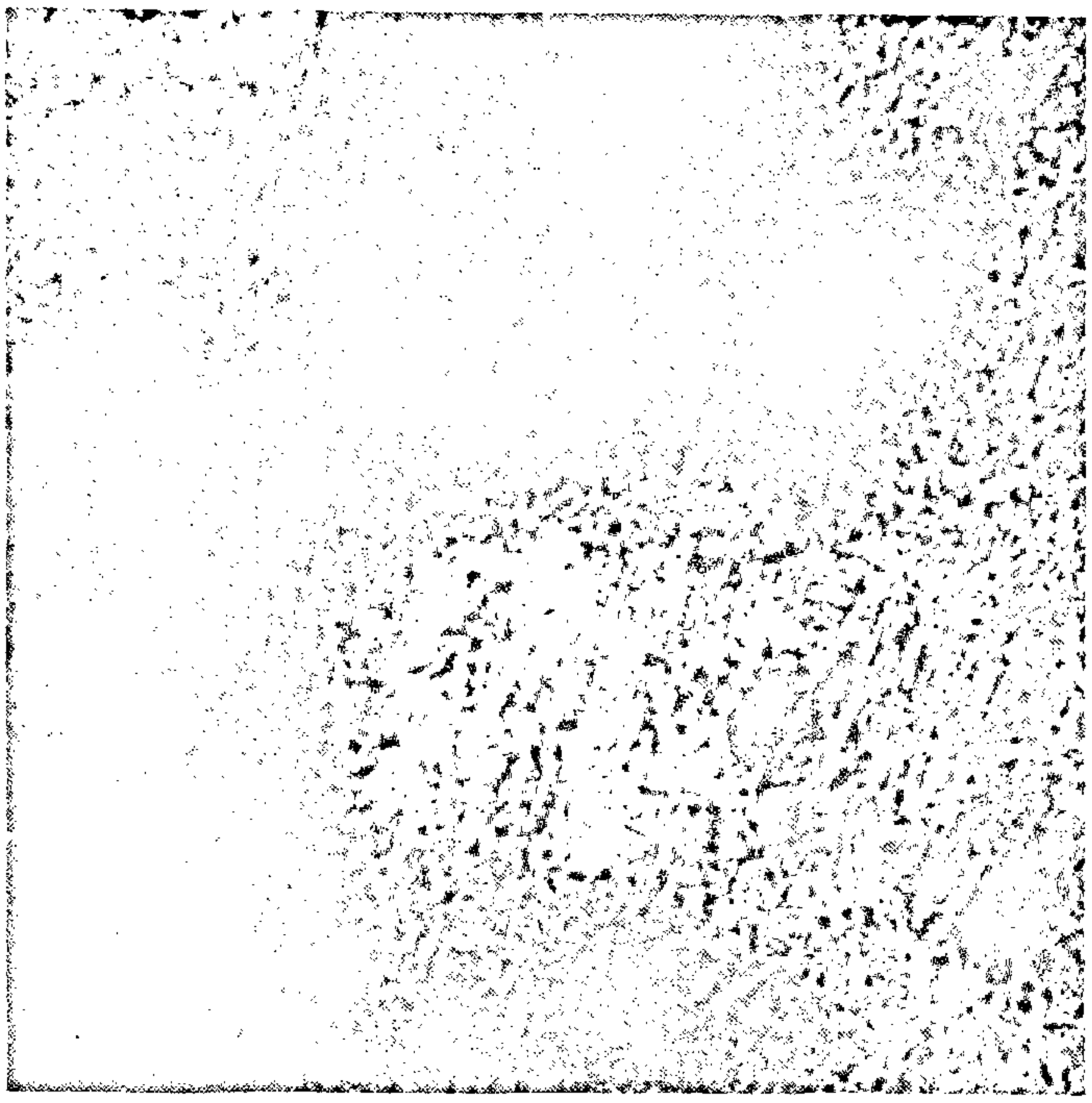

Figure 2. Pasture cover based on NDVI of IRS-1A data. Green through yellow, cyan, magenta and brown represent optimum cover to barren lands.

classes of a desert pasture land and the derived statistics are given in figure 2 and table 2 respectively.

However, it needs to be recognised that diminution of vegetation cover is only one of the indicators of pasture land degradation. The ratio of palatable and unpalatable species, is also important. Work to decipher floristic composition employing supervised classification or intimate mixture analysis based on RS data is being perused. Efforts are also on to monitor waterlogging and salinity and ground water over-draft from IRS-1A data.

Table 2. Vegetation cover classes from IRS data in an open pasture land south of Nachna, Jaisalmer

	Land categories	Percentage of total area	Area under each' category (hectares)
1.	Optimum cover	7.19	2478.85
2.	Slightly degraded	9.49	3268.07
3.	Moderately degraded	24.85	8559.28
4.	Severely degraded	20.11	6926.42
5.	Nearly barren	38.36	13214.74

REFERENCES

1. UNCOD A/CONF 74/36, *Rep. UN Conf. Desertification,* Nairobi, 1977, 7.
2. Dhir, R. P., *Proc. Nat. Symp. on RS in Rural Development. Hissar.* Nov. 17–19, 1990, 93.
3. Sharma, S. A., Bhatt, H. P. and Ajai, *J. Indian Soc. Rem. Sens.* 1990, **18** (3), 25.
4. Shankar, V. and Kumar, S., *CAZRI Pub.* **27**, 1987, 56.
5. Tucker, C. J. and Justice, C. O. *UNEP Bull. Desertification Control,* 1986, 2.