Paper presented at the 22nd Asian Conference on Remote Sensing, 5 - 9 November 2001, Singapore.

DELINEATION AND MONITORING OF GULLIED AND RAVINOUS LANDS IN A PART OF LOWER CHAMBAL VALLEY, INDIA, USING REMOTE SENSING AND GIS

Padmini Pani and S.N.Mohapatra
School of Studies in Earth Science, Jiwaji University, Gwalior - 474 011
Madhya Pradesh , India
Phone : +91-0751-230336; Fax : +91-0751-341450; Email : panip99@yahoo.co.uk

KEY WORDS : Chambal Valley, Ravinous, Principal Component Analysis

ABSTRACT

Chambal Valley of India is particularly well known for its characteristic deep-cutting ravines, which has been spreading over the usable land at an alarming rate. The damage to the agricultural land by network of gullies and later its conversion to deep ravines is a serious concern to the scientific community since long back. . A part of the Chambal Valley is considered for the present study with the main objective to delineate and monitor the gullied and ravenous lands with the help of multi temporal remote sensing data and GIS. The delineation of ravinous land has been accomplished initially from Survey of India topographic base map (1985) and IRS-1B (1996) data. Subsequently, employing various digital enhancement techniques to IRS-1C LISS III and PAN (1998) data, updated ravine-affected area in the study area has been delineated and various ravine classes based on their average depth have been categorized. Principal component transformation to all four bands of LISS III data and generation of FCC from first three principal components, and finally fusion of LISS III and PAN data by principal component analysis (PCA) have been employed in this work. Finally, from the multi temporal data sets, viz., Survey of India topographic base map (1985), IRS-1B LISS II (1996) and IRS-1C LISS III and PAN (1998) data, an attempt has been made to study the advancement and recession of ravines in the study area by using the Integrated Land and Water Information System (ILWIS) 2.2 software. It has been observed that the affected area during the 15 years time period (1984-1998) has been increased from 35.37 % to 38.94 - % of the study area. The actual spreading rate at different localities in the study area was recorded from the local villagers and compared with the result obtained from remote sensing techniques. The result obtained from this study is found to agree significantly well with the actual figures collected during field investigation.

INTRODUCTION

The word 'ravine' denotes gullied land containing systems of gullies running more or less parallel to each other and entering a nearby river flowing much lower than the surrounding table lands. It is associated with an isolated gully. The lower Chambal valley of Madhya Pradesh is highly affected by gully erosion. In the past few decades, the Chambal ravine has become a national problem. The formation of ravines has been posing serious problems to the agricultural and irrigation planning of the lower Chambal valley. These ravines are constantly damaging the valuable fertile land. Increased utilization of marginal lands in the periphery of the gullied and ravine areas for cultivation activities during the recent decades has lead to further growth of ravines in new areas.

The damage to the agricultural land by network of ravines and later its conversion to badland topography is a serious concern to the scientific community since long back. Attempts have already been made by a number of workers in mapping the ravinous lands using available remote sensor data as well as in studying their geomorphological aspects. The remote sensing data provides excellent information about spatial distribution of land in less time and cost effective manner. The accuracy and reliability of mapping and monitoring of gullied and ravenous lands has been considerably improved with the availability of IRS 1C /1D and PAN data having much higher resolution than the earlier satellites.

The present investigation has been carried out with an integrated Remote Sensing approach along with the conventional methods. The Remote Sensing techniques, Geographic information System (GIS) techniques, has been integrated in this present study and ravine analysis particularly for the change detection study of ravine-affected land.

MATERIALS AND METHODS

The selected study area is a part of Lower Chambal Valley lies near Sabalgarh town in both M.P. and Rajasthan states. The area covering about 691.65 sq.km., is located between 26°15′ to 26° 30′ N latitude, and 77°15′ to 77° 30′ E longitude, which falls in the survey of India topographic sheet NO 54 F/7. Physiographically

a major part of the area is covered by thick alluvium deposited by Chambal River and its tributaries. The area to the north of Chambal River is characterized by deeply dissected plateau and resulting undulating topography. To the extreme south, the presence of residual hills gives a locally uneven physiography. In the central part i.e., on both sides of Chambal River, ravine lands gives over-all badland topography. The satellite data products used for the detailed image processing of the area around Sabalgarh are:

I. IRS-1B LISS-II georeferenced standard FCC hardcopy path-28 and row 49, of March, 1996
II. IRS-1C LISS-III, path 97 row 53, of November, 1998
IRS-1C PAN, path 97 row 53, of November 1998

The ILWIS 2.2software is used in the preparation and analysis of present investigation. It is a Geographic Information System (GIS) with image processing capabilities. The outline of ravine-affected areas of the area was delineated separately from Survey of India topographic base map dated 1985 and IRS-1B LISS II data dated 1996. IRS-1C PAN and LISS-III data were geometrically corrected by collecting ground control points (GCPs) with respect to Survey of India topographic base map. Survey of India topographic base map dated 1985 has been georeferenced collecting 14 GCPs using affine transformation with an RMS error of 0.468 pixel. IRS 1C PAN data has been geometrically corrected taking 14 uniformly distributed GCP's from SOI Toposheet (scale 1:50,000) with an RMS error of 1.2. IRS 1C LISS III data has been geometrically corrected with respect to PAN data collecting 14 ground control points, with RMS error of 0.86.

Nearest neighbour-hood method has been used in georeferencing the PAN image whereas convolution method has been used in georeferencing LISS-III image The standard FCC and hybrid FCC 543 have been generated from LISS-III data assigning red, green and blue to band 4, band 3, and band 2 and band 5, band 4 and band 3 respectively. Principal component transformation has been performed on all the four bands of LISS III data. In this work, an FCC has been generated assigning red, green and blue to PC1, PC2 and PC3 respectively.

Subsequent to digital image processing of IRS-1C LISS III data to standard FCC, hybrid FCC 543 and FCC generated from first three principal components of LISS III data, the ravine outline map obtained from LISS II data was duly modified and validated during field investigation. Principal Component Analysis (PCA) method has been employed for merging IRS-1C LISS III and PAN data.

OBSERVATIONS AND RESULTS

The types of ravines with respect to their average depth in to shallow, moderately deep and deep ravines (all qualitative) may be discriminated to some extent from the false colour composites, but the delineation of areas under each of these three categories have been found best possible from fused image products of IRS-1C LISS III and PAN data. The ravine affected areas and areas covered by marginal agricultural lands have been computed digitally from the above two ravine maps **(Table 1)**. It has been observed that total ravine lands in the study area have been increased from 35.37 % to 38.94- % during the 15 years (1984-1998) period. However, the area extent of marginal agricultural lands has been found to increase from 23.99sq km to 27.14sq km during the same period Two ravine maps, one from survey of India topographic sheet dated 1985 and another from IRS-1C LISS III and PAN Data dated 1998, were compared to obtain the change in ravine affected area. It has been observed that the affected area during the 15 years time period (1984-1998) has been increased from 36.33%-53.27% of the study area. Hence, the net increase in ravine-affected area may be calculated as 16.94% during the said period.

During the field investigation, the spreading rates of ravine at different locations of the study area were recorded. The spreading rate figures of different locations were overlain on the Ravine change map **(Fig. 1)**. It has been observed that the spreading rate figures matches significantly for many a points with the change in ravine affected areas obtained from this study. The new affected area is more in the N.E. part and central part of the area.

DISCUSSIONS

The FCC generated from first three principal components of LISS-III data have great potential in identifying the ravine lands. Further more the potential of synergic LISS-III and PAN data has been evaluated in identifying and discriminating ravines according to their average depth. An attempt has been made to classify ravines in to shallow, moderately deep and deep ravines based on their average depth <5m, 5m-20m and >20m respectively. The result obtained has been found to match significantly the selective field data.

As it is mentioned earlier that total ravine lands has been increased from 35.37 % to 38.94- % during the 15 years (1984-1998) period and that of marginal agricultural lands from 23.99sq km to 27.14 sq km during the same period, this probably accounts engulfment of new agricultural lands due to growth of ravines as well as development of old or matures ravine lands to agricultural lands as observed during the field investigation. This

has been observed particularly in cases where side slope of the ravines is very gentle or ravines are characterized with wide base-width.

ACKNOWLEDGEMENT

The author wish to place on record her sincere thanks to Dr. U.C.Singh, Professor, School of Studies in Earth Science, Jiwaji University, Gwalior, for evincing keen interest and providing necessary facilities during the course of investigation.

REFERENCES

Karale, R.L., Saini, K.K., and Narula, K.K. 1988 . Mapping and monitoring ravines using remotely sensed data. *Journal of Soil Water Conservation, India* 32, 75.

NRSA (1986): Manual of Procedure for Wastelands Mapping using remote sensing techniques. *NRSA, DOS, Hyderabad*

Singh, A.N., Pant,B.C. and Siddiqi,T.H. 1987. Monitoring Gullies and Ravine Lands in Western Uttar Pradesh, Topographical Maps and Landsat TM data, *Proceedings of "National Symposium on Remote Sensing in Land Transformation and Management", I.S.R.S., Dehradun*

Singh, A.N., Sharma, Y.K and Singh, Sanjay 1999. Evaluation of IRS-1C PAN data for monitoring gullied and ravenous lands in western Uttar Pradesh, *Remote Sensing and Geographical Information System for Natural Resource Management, A Joint Pub. Of ISRS and NNRMS, 149-160*.

Stephens, P.R. and Chilar, J. 1981. The potential of remote sensing to monitor soil erosion on cropland. *Proc. Fifteenth Int. Symp. Rem. Sem.Enriron, ERIM, Ann Arbor, MI*

Table – 1

MULTI TEMPORAL STATUS OF RAVINE LANDS IN RELATION TO AGRICULTURAL LANDS IN THE STUDY AREA

Source(s) of information	Year	Total Area (sq km)	Marginal Agriculture Land (sq km)	Ravi		
				Shallow Ravines (sq km)	Moderately Deep ravines (sq km)	Deep (sq
Survey of India Topographic Sheet	1985	691.65	23.99	--	--	
IRS –1B LISS II standard FCC	1996	691.65	27.14	54.31	105.90	10
IRS-1C LISS III and PAN digitally enhanced data products,	1998					

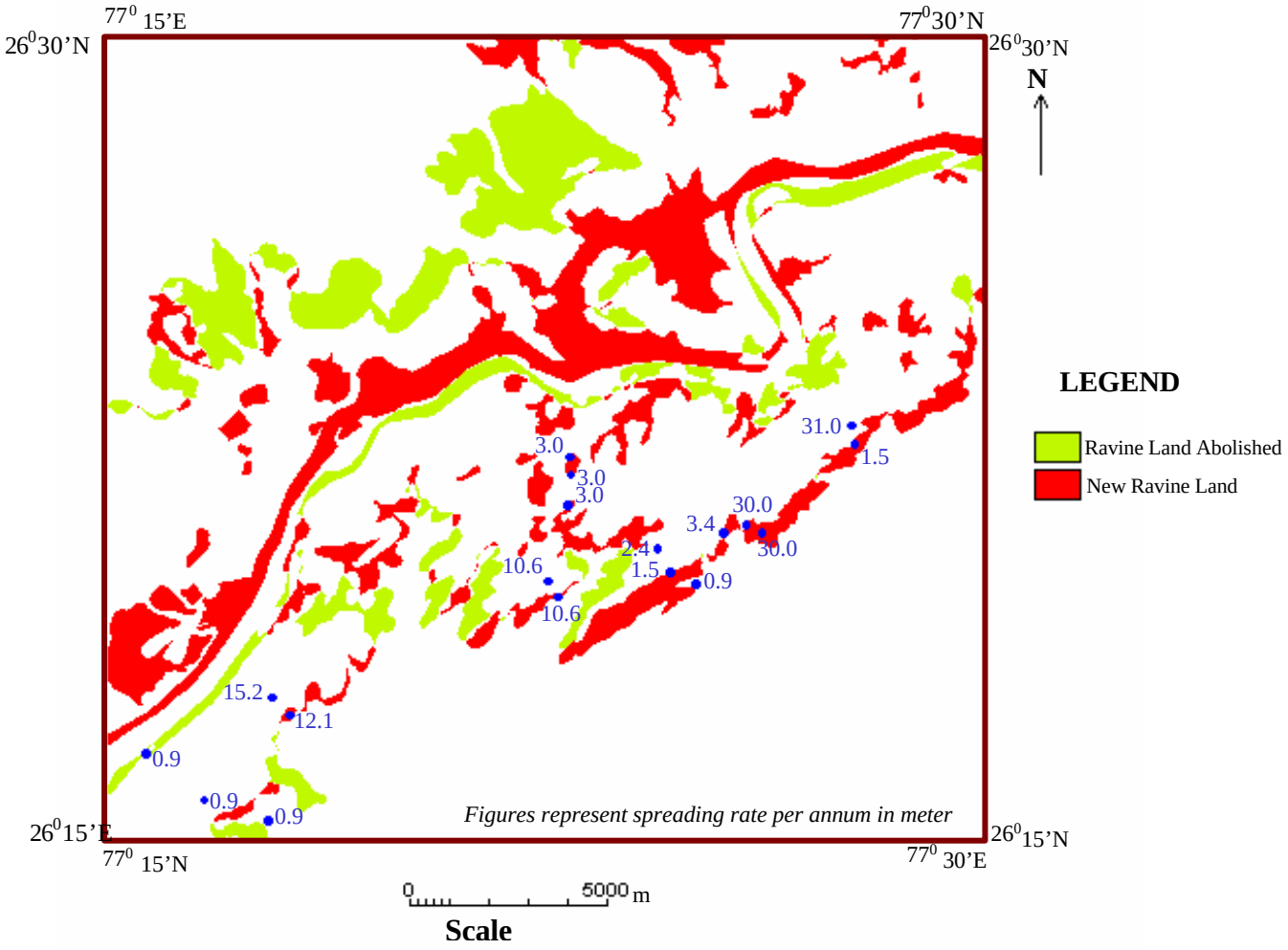

Fig. 1 Ravine Change Map of the study area during 1984 to 1998