Indian Journal of Ecology (2022) 49(2): 603-607
DOI: https://doi.org/10.55362/IJE/2022/3567

Manuscript Number: 3567
NAAS Rating: 5.79

Identification and Mapping of Land Degradation through Remote Sensing in Budgam District of Jammu and Kashmir, India

Nusrat Rafique, M. Sultan Bhat and Tahir Hussain Muntazari[1]

Department of Geography and Disaster Management, University of Kashmir, Srinagar-190 006, India
[1]Department of Civil Engineering, National Institute of Technology, Srinagar-190 006, India
E-mail: nuxurafique5@gmail.com

***Abstract*:** The present study is to assess the land degradation in the Budgam district of Jammu and Kashmir with the use of multi temporal satellite images of Sentinel II data of three seasons of the year 2018 with the spatial resolution of 10 metres within the third, fourth, and the Eighth bands in conjunction with the ground-truthing of the study area. The evaluation was done with the utilization of visual interpretation keys like tone, texture, etc in Arc GIS 10.2 Software. Based on the severity of the land degradation the study area was mapped into categories of anthropogenic (mining), barren rocky/ stony waste, water erosion gullies and water erosion ravines. Out of 1371 square kilometres of the study area, approximately 129.20 square kilometres are degraded, out of which 118.84 square kilometres were categorized into the barren rocky stony waste class, which is due to the undulating topography (Kandi) of the realm. The decrease in the vegetation cover and also the transformation of the agricultural land into horticulture and other commercial activities is the reason for the land degradation. This paper will function as an input to the planners, district system for monitoring and management of the severity of land degradation within the area.

Keywords: Land degradation, Identification, Mapping, Budgam, Brick kilns, Visual interpretation

One of the most serious universal ecological issues that threaten the world food security, resulting in adverse effect on agricultural yield is land degradation. Principal processes of land degradation include erosion by water and wind, chemical deterioration (comprising acidification, salinization, etc), physical deterioration (comprising crusting, compaction, hard-setting etc.) and biological deterioration (reduction in total biomass carbon, and decline in land bio-diversity) . Soil erosion and biodiversity loss being the main causes of land degradation in the less populated areas, while water shortage, soil depletion and soil pollution are most typical within the most agricultural areas (Nachtergaele et al 2011). Almost 250 million people are directly affected by land degradation (UNCCI), and may be a reason of decline in the quality and quantity of freshwater supplies, soil productivity which ends up in greater food insecurities, increase in poverty and greater social costs (Aggarwal et al 2013). Land degradation being the foremost common and grave environmental issue within the world, it has affected two billion hectares (22.5%) of the world's agricultural land, grasslands, forest and woodland (Al Dousari et al 2000). Livelihood of more than 900 million people in almost 100 countries is directly and adversely affected by land degradation. Climate is one of the causes of desertification in China, but anthropogenic causes are dominant (FAO 2005). The countries in the developing world, especially, those in the arid and semi-arid regions, are much affected. Agriculture is one of the foremost environment modifying factors.While soil deterioration may be a major aspect of land degradation, processes like deforestation and lowering of the water level is also a part of land degradation (Zalidis et al 2002).

Resourcesat-1(P6) LISS was visually interpreted and therefore the area was divided into the categories of un-degraded, moderately degraded, degraded etc (Krishna et al 2008). Tagore et al 2012 delineated the Rajgarh district of Madhya Pradesh into the categories of barren rocky/ stony waste, water erosion gullies, sheet erosion categories of degraded lands by the visual interpretation of FCC of LISS III data of 23 meters resolution.Therefore the aim of this is to identify and map different categories of land degradation in Budgam District of Jammu and Kashmir using remote sensing data and to evaluate it.

MATERIAL AND METHODS

Study area : Budgam the territorial dominion of Jammu and Kashmir located within the Central part of Kashmir and covers an area of 1371 km sq. between 33° 48' 43”North to 34° 08' 43″North and 74° 31' 51″ East to 74° 55' 03'East with altitude of 1610 meters (Fig. 1). It is bound by district Baramulla in North-West and Srinagar in the North-East and South-West and Pulwama Poonch and Shopian bound this area in the South. The realm consists of the lofty Pir Panjal and flat topped Karewas which are locally known as Wudars. Karewas are the lacustrine deposits of the Pleistocene

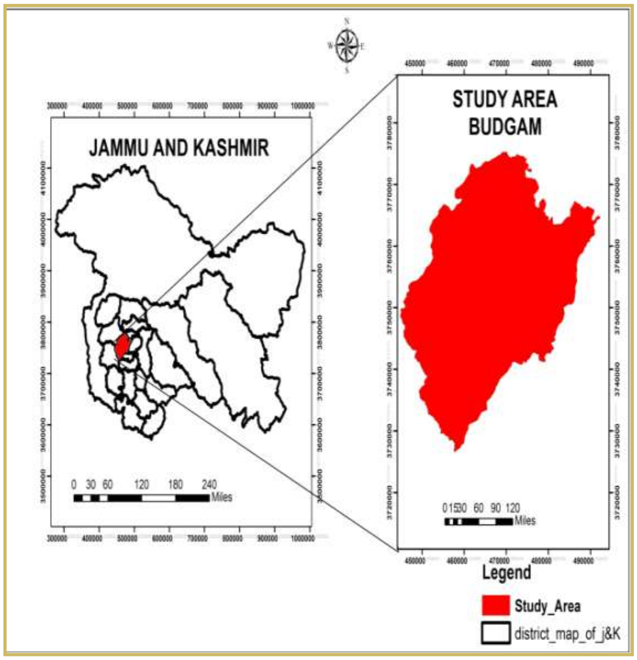

Fig. 1. Study area map

Period. Blue, grey and buff clays and silt, partly compacted conglomerates and sandstones, pebble beds and embedded moraines are some of the different kinds of lithology types.The soils within the area are generally of three types, viz., loamy soil, karewa soil and poorly developed mountain. Climate of the study area is temperate type with warm summers and cold winters.

Geo Spatial techniques were used for the assessment of land degradation within the study area. The satellite imageries employed in this study are from the United States Geological Survey (USGS) earth explorer (https://earthexplorer.usgs.gov).The initial knowledge about the study space was obtained from the false colour composite of the Sentinel II images. The spatial resolution of the image is 10 metres in band third, fourth and band eighth (RGB). The imageries of three season's viz. Kharif, Rabi and Zaid in conjunction with ground truthing was used. Since the multi temporal satellite images were used, because most of the hilly terrain is enveloped by the snow for almost two seasons which then becomes visible almost during the kharif season and therefore the images of multi seasons were being employed for mapping.The bands were layer stacked and the area of interest (AOI) was extracted from it and also various geometrical corrections were done in the images through the use of ERDAS IMAGINE software. Deductive logic approach was followed to delineate various land degradation categories in which, the areas where there is no scope for land degradation was delineated first. Subsequently, the land degradation units that are quite evident are delineated followed by areas which required more logical analysis.

Various geometrical corrections were done by the utilization of ERDAS IMAGINE software. Spatial filters like high pass filters for gullies and ravines were used. Image pre-processing is extremely important to determine a more direct association between the acquired data and biophysical phenomena. The method of visually interpreting digitally enhanced imagery attempts to optimize the congratulatory capabilities .Visual mode of interpretation (Domlija et al 2019) techniques through the use of interpretation keys like texture, tone, hue, aspect, association and aspect (Sahu 2007) through the utilization of ARC 10.2 followed by ground verification has been employed for mapping degraded lands.

Image interpretation keys (tone, size, shape, texture) were used to identify the degree and harshness of land degradation (Table 2). The interpretation was then supported by ground truthing. During the ground truthing a similarity amid the image elements and identified land degradation classes was tried to be established during the interpretation.

Assessment of classification accuracy was carried out to determine the quality of information derived from the data. A stratified random method of accuracy assessment was used to represent different Land degradation classes in the area. The accuracy assessment was carried out based on ground truth data and visual interpretation. The overall accuracy is 83.52 (Table 3). The comparison of reference data and classification results was carried out statistically using error matrices. Besides, a nonparametric kappa test was also performed to measure the extent of classification accuracy. The Kappa Statistics for the agreement are 0.78. However, a decline in accuracy could be due to difference between the ground survey and that of the resolution of remote sensing data.

RESULT AND DISCUSSION

The total area of the study space is 1371 square kilometres. Of the total study space, 129.20 square kilometres are degraded. Of this, barren rocky/stony waste cover 118.84 square kilometres (7.76%), anthropogenic activities (mining) cover 7.17 square kilometres (0.52%), water erosion gullies account for 0.24 square kilometres (0.01%) and water erosion ravines account for 2.95 square kilometres (0.13%) (Table 2). The entire degraded areas identified and mapped (Fig. 2).

Barren rocky/stony waste: This appears as light brownish or light maroons in color. They occur as discrete or continuous patches altogether, the three season data. These are mostly found in hilly areas or within the areas of rough terrain. The entire area of degraded land falling under the category of barren rocky /stony waste is 118.84 square

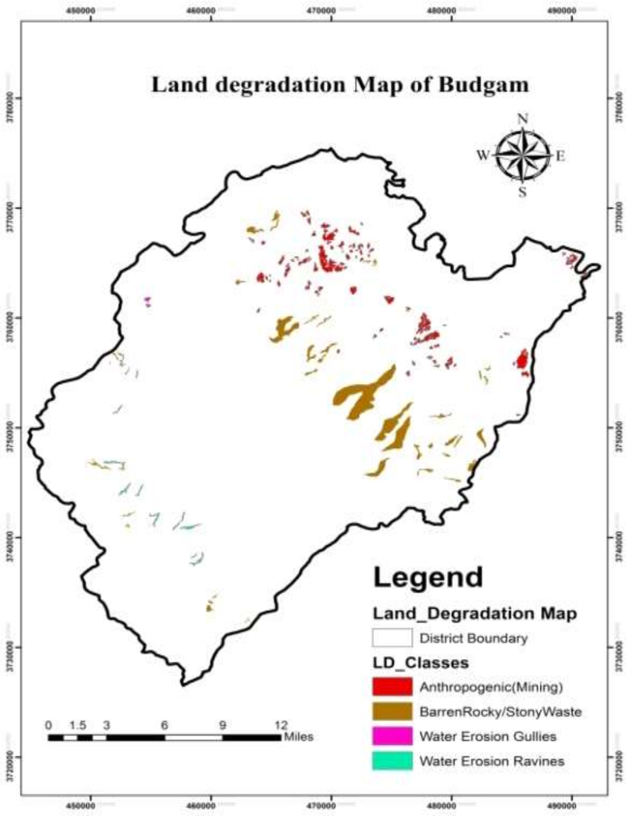

Fig. 2. Land degradation map

kilometers which is 8.66% of the entire geographical area of the district.

Anthropogenic activities (Mining): it includes stone query, surface rocks, excavations, sand and gravel pits, and excavating soil for brick kilns etc. It appears as light yellow with rectangular light bluish patches. It is clearly visible altogether season data. The anthropogenic activity mainly included in this area is excavating the soil for brick kilns. The area falling under this category is 7.17 square kilometers which is 0.52% of the entire area of the study area.

Water erosion ravines: Ravines are most intense style of erosion with complex style of networks formed by gullies with greater drainage density. Their steepness decreases because the distance increases from the system, and therefore the image texture becomes smooth. The entire area under ravines is 2.95 square kilometers which accounts

Table 2. Degraded land categories of study area

Land degradation class	Area (sq.km)	Percentage
Anthropogenic (mining)	7.17	0.52
Barren Rocky/Stony Waste	118.84	8.66
Water Erosion Gullies	0.24	0.01
Water Erosion Ravines	2.95	0.21
Total	129.20	9.4

Table 1. Visual interpretation keys for mapping of land degradation

Process	Colour	Shape	Texture	Pattern	Size	Shape	Association
Water Erosion	Slightly brighter grey to dark grey than surrounding land	Irregular	Smooth medium to course	Contiguous / Discrete Patches to Contiguous Patches	Small to Large	Irregular	Slopping cultivated land with poor vegetation in rainy season
Gullies	Brighter than surrounding land/grey in colour depending on soil colour	Irregular	Medium to slightly course	Discrete to contiguous patches	Small to medium	Irregular	First order streams
Wind Erosion	Light Grey/yellow to Pink mottles	Irregular/Regular	Smooth medium to course	Contiguous / Discrete Patches to Contiguous Patches	Large to very Large	Irregular/Regular	
Water logging	Light blue to very dark blue	Irregular/Regular	Smooth	Discrete patches	Small to large	Irregular	Depressions in inlands/ coastal plains.
Salinization/alkalization	Light grey to white	Irregular	Smooth	Discrete patches	Small to medium	Irregular	Coastal plains young alluvial plains/ stream courses/ irrigated canal commands
Acidification	Various shades of green black	Irregular	Smooth-Medium	Discrete patches	Small to large	irregular	Lateritic high rainfall region, cultivated peats/ marshes.
Anthropogenic(industrial effluent , mining, brick kilns)	Shades of white , red , black and yellow	Irregular/Regular	Smooth-Medium	Discrete	Small to medium	Irregular	Hilly/ plain areas
Barren Rocky/ Stony Waste	Light to medium; grey / yellowish white	Irregular	Smooth	Discrete/Contiguous	Small to medium	Irregular	Hilly/ plain / pediment areas.

Table 3. Error matrix of land degradation

Class name	Error Matrix of land degradation				
	Reference total	Classified totals	Number correct	Users accuracy	Producers accuracy
Anthropogenic (Mining)	23	22	19	86.36	82.6
Barren Rocky/Stony Waste	21	22	18	81.81	85.71
Water Erosion (Ravines)	21	22	18	81.81	85.71
Water Erosion (Gullies)	19	19	16	84.21	84.21
Total	84	85	71	Overall classification accuracy 83.52%	
				Overall Kappa coefficient 0.78	

for 0.21% of the entire geographic area of the study area.

Water erosion gullies: These are mostly on sloping areas. It appears lighter than the encompassing areas with fine texture. The entire area under gully erosion is 0.24 square kilometers which accounts for 0.01% of the entire geographical area of the study dominion.

Different factors were responsible for LD within the area. The population of the area increased from 6, 29,309 lakhs (Anonymous, 2001) to 7, 53,745 lakh (Anonymous 2011) with a rise of 1, 24,436 lakh persons during ten years. Most of the population being agriculture dependent clear the forests for agriculture purposes due to which land becomes devoid of vegetation and becomes susceptible to degradation. The agricultural land within the area is transformed for the most anthropogenic activity that is excavating soil for brick kilns. The DEM of the study area reveals that the area is sloped (1530-4621 DEM ranges) thus the upper reaches being highly sloped are empty of vegetation which ends up in barren rocky /stony waste style of degradation. The soils of the Karewa foot slopes and foot slopes of hills being terraced and bounded with fine texture and are to some extent erosive in nature. Gully erosion is mainly seen in steep river flow, when there are heavy rains; the surface runoff along the river washes away the debris thus affecting growth of vegetation. They are mostly common on sloping surface. Gully erosion prompts loss of topsoil which has major physical and economic presumptions (Pani et al 2011). The implications of gully erosion are not only loss of agricultural land; in several places it has also resulted in the involuntary shifting of villages (Pani et al 2001).

CONCLUSION

This study describes the procedure of identification and mapping of various categories of land degradation like, anthropogenic activities, barren rocky/ stony waste, water erosion gullies and water erosion ravines land degradation phenomena, using the visual interpretation of Sentinel II data of 10 meters resolution in third fourth and eighth band (RGB) imagery from USGS Website. The execution of this system has proven useful in determining the spatial extent of assorted categories of degraded lands within the area. The degraded area is 9.4 % of the entire study area. Within the hilly terrain the most degradation is mainly the barren rocky/ stony waste which is due to the undulating terrain of the high slopes, and account for the great degree of severity. Within the settlement area the debasement is mainly due to anthropogenic activities including excavation of soil for brick kilns. The degradation categories like gullies and ravines also can't be neglected. This work may be used as a plan to spot and prioritize potential areas for reclamation and will serve as a tool for analysis of environmental sensitivity at regional scale and the identification of hotspots of land degradation. The present study would help to identify areas vulnerable to land degradation. This would also help in achieving better results with limited investment and avoid wastage of natural resources.

REFERENCES

Aggarwal PK, Baethegan WE, Cooper P, Gommes R, Lee B, Meinke H and Sivakumar MVK 2010. Managing climatic risks to combat land degradation and enhance food security: Key information needs. *Procedia Environmental Sciences* **1**: 305-312.

Al-Dousari AM, Misak R and Shahid S 2000. Soil compaction and sealing in Al-Salmi area, western Kuwait. *Land Degradation & Development* **11**(5): 401-418.

Anonymous 2001. *Census of India 2001: Provisional Population Totals.* Registrar General and Census Commissioner of India Ministry of Home Affairs, New Delhi.

Aggarwal PK, Baethegan WE, Cooper P, Gommes R, Lee B, Meinke H and Sivakumar MVK 2010. Managing climatic risks to combat land degradation and enhance food security: Key information needs. *Procedia Environmental Sciences* **1**: 305-312.

Al - Dousari AM, Misak R and Shahid S 2000. Soil compaction and sealing in Al-Salmi area, western Kuwait. *Land Degradation & Development* **11**(5): 401-418.

Anonymous 2001. *Census of India 2001: Provisional Population Totals.* Registrar General and Census Commissioner of India Ministry of Home Affairs, New Delhi.

Anonymous 2011. *Census of India 2011: Provisional population totals.* Registrar General and Census.

Aslam M, Srivastava RS, Minocha AK and Gupta RG 1994. Air pollution hazards from brick kilns. *Journal of The Institution of*

Engineers (India) **74**: 83-87.

Đomlija P, Bernat Gazibara S, Arbanas Ž and Mihalić Arbanas S 2019. Identification and Mapping of Soil Erosion Processes Using the Visual Interpretation of LiDAR Imagery. *ISPRS International Journal of Geo-Information* **8**(10): 438.

Iqbal M, Sajjad H and Bhat FA 2013. Morphometric analysis of Shaliganga sub catchment, Kashmir Valley, India using geographical information system. *International Journal of Engineering Trends and Technology* **4**(1): 10-14.

Krishan G, Kushwaha SPS and Velmurugan A 2009. Land degradation mapping in the upper catchment of river Tons. *Journal of the Indian Society of Remote Sensing* **37**(1): 119-128.

Lillesand T, Kiefer RW and Chipman J 2015. *Remote sensing and image interpretation*. John Wiley & Sons.

Nachtergaele F, Biancalani R and Petri M 2011. *Land degradation: SOLAW background thematic report 3.* Rome: Food and Agriculture Organization of the United Nations.

Oldeman LR 1992. Global extent of soil degradation. *Bi-Annual Report 1991-1992/ISRIC;* 19-36.

Pani P and Mohapatra SN 2001. Delineation and monitoring of gullied and ravenous lands in a part of lower Chambal valley, India using remote sensing and GIS. *Proc. ACRS. Singapore*.

Received 21 November, 2021; Accepted 22 February, 2022

Pani P and Carling P 2011. Land degradation and spatial vulnerabilities: a study of inter-village differences in Chambal Valley, India. *Asian Geographer* **30**(1): 65-79.

Raza M, Ahmad A and Mohammad A 1978. *The Valley of Kashmir: A Geographical Interpretation.* Vikas Publishing House, Pvt. Ltd (New Delhi).

Sahu KC 2007. *Textbook of remote sensing and geographical information systems. Atlantic Publishers & Dist.*

Sharma HS 1980. *Ravine Erosion in India. Concept publications* (New Delhi).

Singh VK, Praveen R and Nair SS 2012. Identification and mapping of land degradation in Ramgarh district of Jharkhand using multi temporal satellite data. *Disaster & Development* **6**(1&2): 79-89.

Tagore GS, Bairagi GD, Sharma NK, Sharma R, Bhelawe S and Verma PK 2012. Mapping of degraded lands using remote sensing and GIS techniques. *Journal of Agricultural Physics* **12**(1): 29-36.

United Nations 1994. Earth Summit Convention on Desertification. *Proceedings of the United Nations Conference on Environment and Development (UNCED),* Rio De Janeiro, Brazil, Department of Public Information, United Nations, New York, USA.