

Assessment and monitoring of the land degradation process in Jaitaran Taluka, Pali District, Rajasthan, using remote sensing data

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Abstract
Desertification is the process of soil erosion occurring in arid, semi-arid, and dry sub-humid regions of the world. Which would end the productivity of the land and turn it into a desert, which would affect the standard of living of billions of people. About 1/3 of the total geographical area of India is subject to Land Degradation. Monitoring and evaluation are primary requirements for tackling and mitigating the problems of land degradation and desertification. The objective of the present paper is to monitor the status of desertification and provide information on the local extent of those that have attained a severe state of desertification in the past 28 years. By analysing 28 years of satellite data for the years 1994 (Landsat-5) and 2022 (Sentinel-2), a desertification map of some parts of the western Indian state of Rajasthan, district Pali, has been prepared. It has been monitored and evaluated over a period of 28 years, resulting in a 28 -year desertification status map to tackle the problems of desertification at the ground level and to plan and implement those suggestion.

Keywords Desertification, Monitoring, satellite data, Desertification status map

INTRODCTION

Desertification is one of the world's biggest environmental problems, affecting about one-fifth of the world's dry land, 70% of the world's land mass, and 1/4 of the world's total land area (Christivetl 2018). The productivity of excess land is lost (Abahussain, Abdu, Al-Zubari, El-Deen, & Abdul-Raheem, 2002). Desertification is the degradation of land productivity on dry land (UNCCD, 1994). Land degradation is the process that occurs due to various types of factors: physical (soil erosion due to wind, water, and sill compression and crusting mass wasting), chemical (acidification, salinization, alkalosis), and biological (vegetal degradation, decline in bio-diversity). By reducing the productivity of productive land, it turns into barren land. Desertification is a multidimensional process. Several authors have reviewed the definition and concept of desertification in the context of s (Ajai et al., 2007; Ajai et al., 2009; Bai, Wang, & Xiong, 2013; Brabant, 2008; Brabant, 2019; Eswaran, Lal, & Reich, 2001; Puigdefabregas et al., 2009; Reynolds & Stafford Smith, 2002; Reynolds et al., 2007; Reynolds The general definition is UNCCD's Desertification is the process of land degradation in which lands in arid, semi-arid, and arid-moist areas turn into deserts due to climate change and other factors, including human activities. (UNCCD 1994) According to the "Desertification and Land Degradation Atlas of India" prepared by the Space

Applications Centre (SAC) for the period 2011–2013, the total geographical area of the country is 96.4 million hectares (29 through the process of deforestation).

According to a report released by the International Panel on Climate Change in August 2019, rapid changes in land use patterns and the intensity and frequency of climatic events such as climate change have adversely affected food security and terrestrial ecological systems, as well as land degradation, in various regions. Has been extended. Desertification has a negative impact on ecological processes while also causing a variety of other ecological issues, such as changes in vegetation properties (biomass, vegetation cover density, loss of soil fertility, and changes in different geographical landscapes with a loss of bio-diversity). In a broader sense, desertification has affected the balance between the demand for and supply of ecosystem services in arid land regions, so tackling desertification is necessary to ensure or sustain the productivity of land for a longer period of time. Is required (UNCCD 2001). It is critical to develop a strategy for recovering land productivity while also mitigating the hazards of land degradation, such as the type and severity of land degradation, the endemicity of the extent of land degradation, and monitoring and evaluation. Remote sensing is that technology. By which the status of land degradation is identified as well as its mapping, monitoring, and sensitivity status. Using remote sensing technology, we get better synoptic, repetitive, and real-time data accuracy than ground methods. Monitoring Langat has long-term monitoring and assessment (Albedo and Kumar, 2013).

In broad-scale research, satellite imagery with a Geographic Information System has been used for land degradation mapping and monitoring, mostly including satellites of Landsat and the Aster Indian Remote Sensing Series with multispectral sensors. These are obtained from satellite data, which we use in land degradation mapping, monitoring, and assessment. Using these indicators, land use patterns, vegetation cover, vegetation biomass, and their total production are known. Many researchers have used models such as the term's use efficiency in this context (Bai, Olsson, & Schaepman, 2008; Dardel et al., 2014; Shoba & Ramakrishnan, 2016; Kundu, Patel, Saha, & Dutta, 2017; Varghese & Singh, 2016; Wessels et al., 2007).

El Kaway et al. (2011) In broad-scale research, satellite imagery with a Geographic Information System has been used for land degradation mapping and monitoring, mostly including Landsat with multispectral sensors and satellites of the Aster Indian Remote Sensing Series. We get many indicators or indicators related to desertification from satellite data, which we use in land degradation mapping, monitoring, and assessment. Using these indicators, land use patterns, vegetation cover, vegetation biomass, and their total production are known. In this context, many research scholars have also used models like efficiency of use.

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STUDY AREA

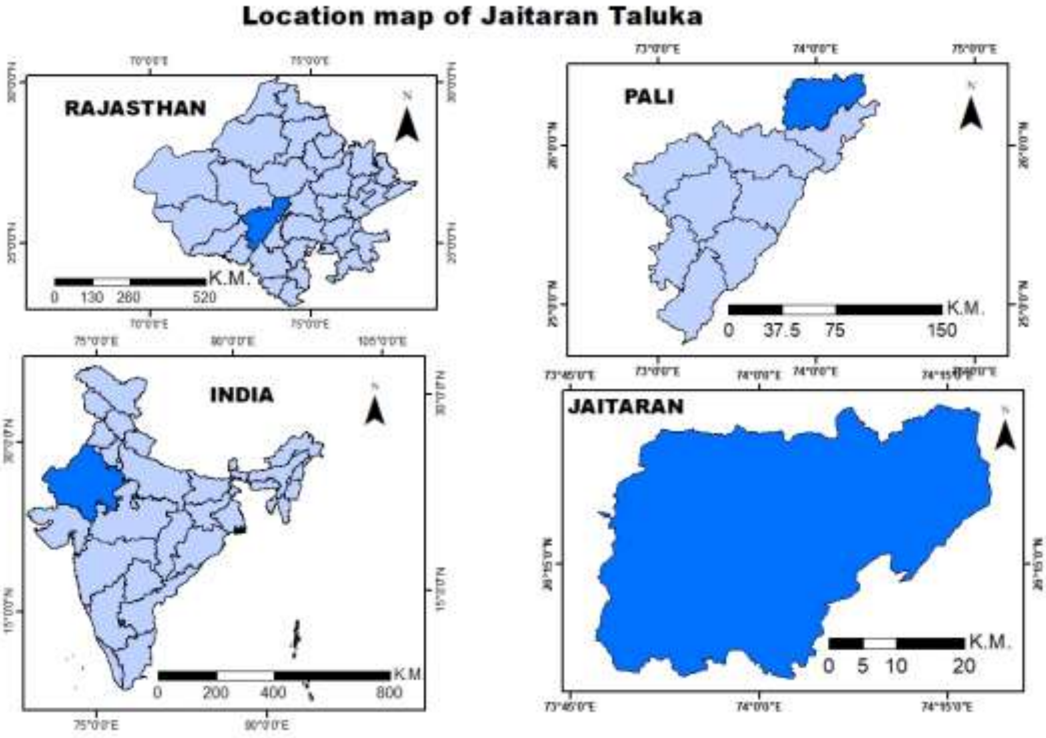

Fig. 1 The map indicates the study area's location.

Jaitaran Taluka (Pali District) is located in the central-eastern part (377 °C) of Rajasthan state in western India. Its area is 1443 km2. It has a latitudinal range of 2 degrees and a longitudinal range of 73.94 degrees east. It is bounded by Nagaur district in the north, Jodhpur district in the west, and Raipur and Sojat taluka of Pali district in the south, west, and south, respectively. The main river flowing through it is to the east is the Aravalli range. In the monsoon season (between July and September), the rainfall is 470 mm. The difference in temperature between July and September is found here. The average temperature throughout the year is 25 degrees Celsius in the winter and 37 degrees Celsius in the summer. According to the agro-climatic zone of India, the study area falls in the arid category (NBSS and LUP, 2001). Open scrub is found in the arid and semiarid parts, whose cover area is declining. Its geological structure is quite complex. This area is made up of various configurations of igneous, sedimentary, metamorphic, and ternary rocks. And there is a deficiency of non-metallic minerals. The study area is endowed with a variety of minerals. There are deposits of good-quality minerals like mica, limestone, gypsum, and magnetite. In the monsoon season (between July and September), the rainfall is 470 mm. The difference in temperature between July and September is found here. Winter temperatures average 25 °C, while summer temperatures average 37 According to the agro-climatic zone of India, the study area falls in the arid category (NBSS and LUP, 2001). Open scrub is found in the arid and semi-arid parts, whose cover area is declining. Its geological structure is quite complex. This area is made up of igneous, sedimentary, and metamorphic rocks of different configurations. And there is a

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deposit of a non-metallic mineral. The study area is endowed with a variety of minerals. There are deposits of good-quality minerals like mica, limestone, gypsum, and magnesia. Most of the people in Jaipur depend on agriculture for their livelihood. Here, two crops are sown in a year, Kharif and Rabi. Kharif crops are harvested between July and September/October, and Rabi crops are harvested between November and April. In some areas, summer crops (May–July) are also grown. Here, cumin and fennel are cultivated, which are the crops of the Rabi season. Along with this, B.T. cotton, moong, sorghum, and millet are also cultivated. For accurate information about different crops and other land covers in this area, Multisensor data from different time periods has been taken. People living in this area have limited sources of income. The mineral wealth in this area provides income opportunities for the locals. Jaitaran Taluka has a huge availability of limestone, which ensures the availability of raw material for the cement industry here. Due to the availability of raw materials, many cement plants are established in this area. In recent times, the farmers of this area have attracted economic benefits and converted their agricultural land to limestone. The cement plant is leased out for quarrying and mining. The mining of stone from the land by the cement plant has caused the physical, chemical, and biological properties of the land to degrade, as well as the ecological degradation of the area and the soil erosion on a large scale in the area. Mining generated due to mining activities Due to wind and transport, fine powder is spread from the material, which adds to the nutrient content and ph. using the value destroys the productivity of the soil and leads the land towards degradation.

2. Data used and methodology

2.1. Data use

Landsat (TM-Thematic Mapper) and Sentinel-2 data were used to map the desertification status for Jaitaran Taluka of Pali District in the western Indian state of Rajasthan. The details of the data are given in Table 1 below. Landsat-5 data and Sentinel-2 data have been used to map land use, degradation processes, and their intensity. The USGS Earth Explorer Program (http://vv.usgus.glovis.gov), which can be downloaded for free, has used Landsat-5 and Sentinel-2 data.

	Table 1: Data used for the study				
	Data used	PATH	ROW	Spatial resolution	Date of acquisition
Satellite data	landsat -5™	148	43	30M	18-01-1994
		149	42	30M	18-01-1994
	SENTINEL-2	T43	RBJ	10M	27-01-2022
		T43	RCK	10M	27-01-2022
		T43	RDK	10M	27-01-2022
		T43	RBH	10M	27-01-2022
		T43	RCJ	10M	27-01-2022
		T43	RDJ	10M	27-01-2022
		T43	RCH	10M	27-01-2022

2.2. Methodology

The Survey of India (SOI) topographic map on a scale of 1:50,000 has been used to demarcate and delineate the boundary of Jaitaran taluka in the Pali district of the western Indian state of Rajasthan. It aims to obtain slope, elevation, and drainage as basic inputs. A base map has been prepared using relevant information about major water bodies, settlements, drainage networks, and major road and rail networks obtained from the SOI map. SOI has also been used for taking Ground Control Points (GCP). Landsat data from different dates has been used to generate land degradation maps of Jaitaran Taluka, as well as Sentinel-2 data. A DSM on a scale of 1:25000 has been prepared to deal with the problem of desertification. Is. The DSM maps have been generated by a three-tier classification system using on-screen digitization techniques. A national-level standardised classification system has been used to prepare the DSM (Ajay et al., 2007).

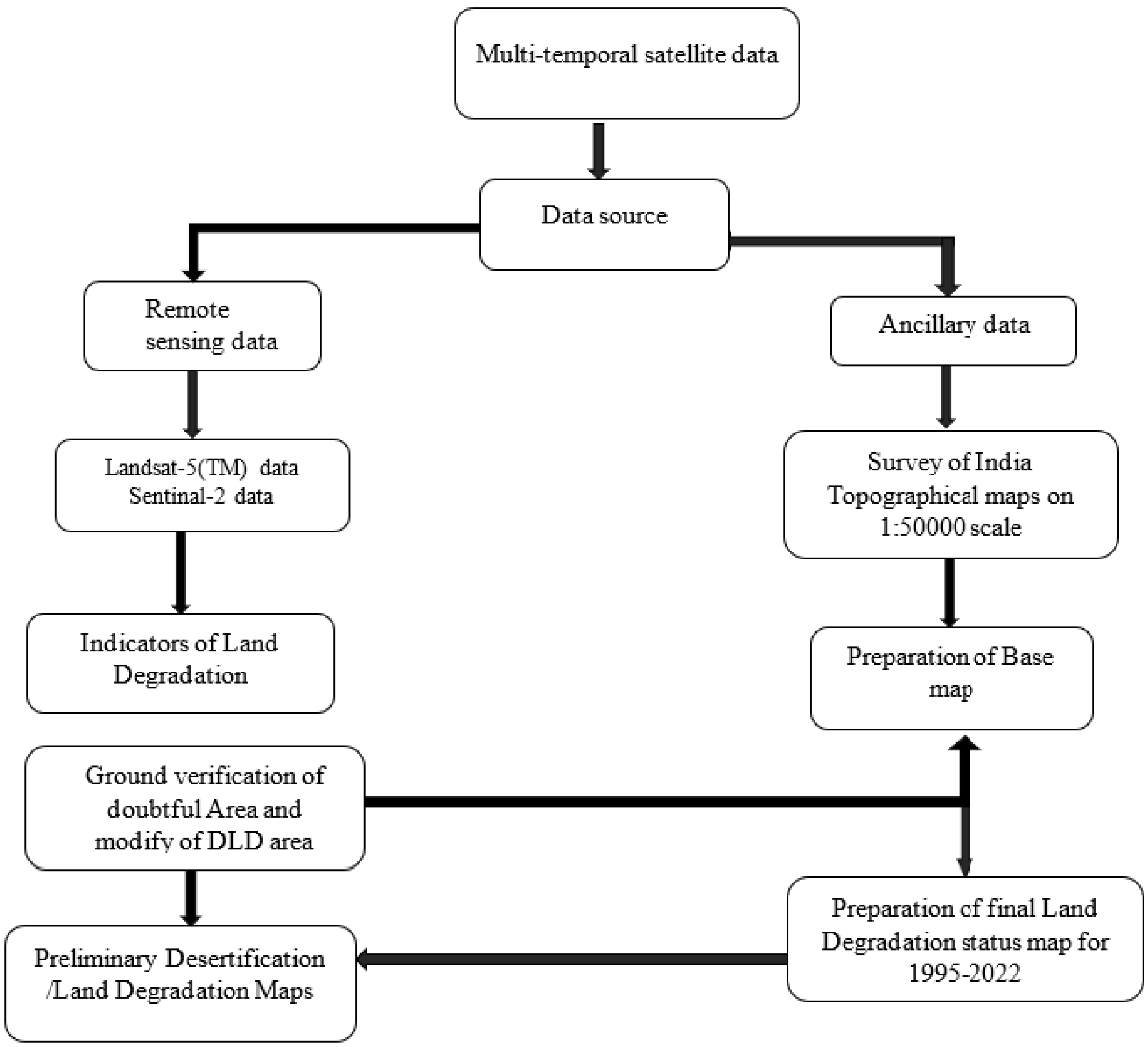

Figure 2. Methodology for preparation of desertification status map

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For making land degradation maps of Jaitaran taluka, maps of the area's land use class, degradation processes, types, and severity of various photographic elements (tone, texture, size, shape, pattern, and association) have been prepared, monitored, and assessed. Has gone. ERDAS and ARC 10.4 have been used for image processing of Landsat 5 (TM) and Sentinel 2. DSM maps of Landsat-5 and Sentinel-2 are scaled at 1:25000 to ARC 10.4. Change detection has been done by DSM maps of Landsat-5 and Sentinel-2 for the last 28 years.

Table 2: Nationally standardised classification system for desertification status mapping (Source: Ajai et al., 2007).

Class	Symbo
Level:1 Landuse/Landcover	
Agriculture – irrigated	I
Forest	F
Land with scrub	S
Barren/rocky area	B/R
Water body/drainage	W
urban, man-made etc.	M
Level:2 Processes of degradation	
Vegetal degradation	v
Water erosion	w
Manmade (mining/quarrying)	m
Level: 3 Severity of degradation	
Severity	Level
Low	1
Moderate	2
Severity	3

Results & Discussions

The land degradation maps of Jaitaran taluka have been prepared at a 1:25,000 scale using Landsat-5 and sentinel data from 1995 and 2022. The land degradation maps presented show the severity as well as the spatial distribution of land degradation processes. The area under various desertification processes during the years 1994 and 2022 is summarised in Table 5 and shown as a pie chart in the figure. The land degradation maps show that the total land area undergoing degradation is 136.64 km in 1995 and 174.62 km in 2022, which is 9.93% and 12.69% of the total geographical area (TGA) of Jaitaran taluka, respectively (Table 5). It

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is clear that the process of land degradation has increased from 1995 to 2022. Land degradation for the year 1995 (Figure 3) states that vegetation degradation and water degradation are the major.

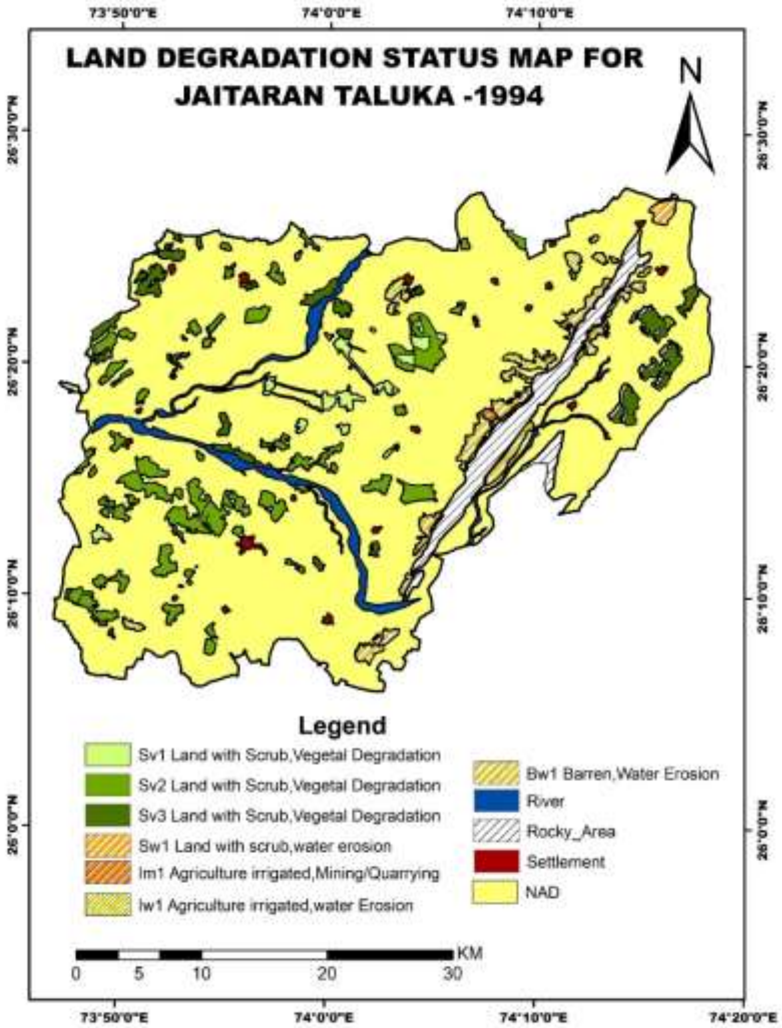

Figure 3. Land degradation status map of Jaitaran for 1994 using Landsat data-5

Desertification processes. Human-induced land degradation, such as quarrying and mining, was not observed in 1994 (Fig. 3). In contrast, the 2022 land degradation study shows mining and quarrying activities in the area. Quarrying and mining in this area are mainly for limestone required for the cement industry. Land degradation for the year 1994 (Fig. 3) states that vegetation degradation and water degradation are the major desertification processes. Human-induced land degradation, such as quarrying and mining, was not observed in 1994 (Fig. 3). In contrast, the 2022 land degradation study shows mining and quarrying activities in the area. Quarrying and mining in this area are mainly for the limestone required for the cement industry. Mining and quarrying with increased area under vegetation degradation and water erosion during 1994–2022 are mainly observed in barren, rocky areas and on agricultural lands. Mining and quarrying on agricultural land (in part of the study area) have been found mainly in the eastern and western parts of the study area. Mining and quarrying have been found mainly in the eastern part of the study area in barren, rocky areas. Local

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farmers are leasing out their agricultural land for limestone mining. This can be attributed to the poor and shallow soil of the region as well as the socio-economic conditions of the people occupying these agricultural lands.

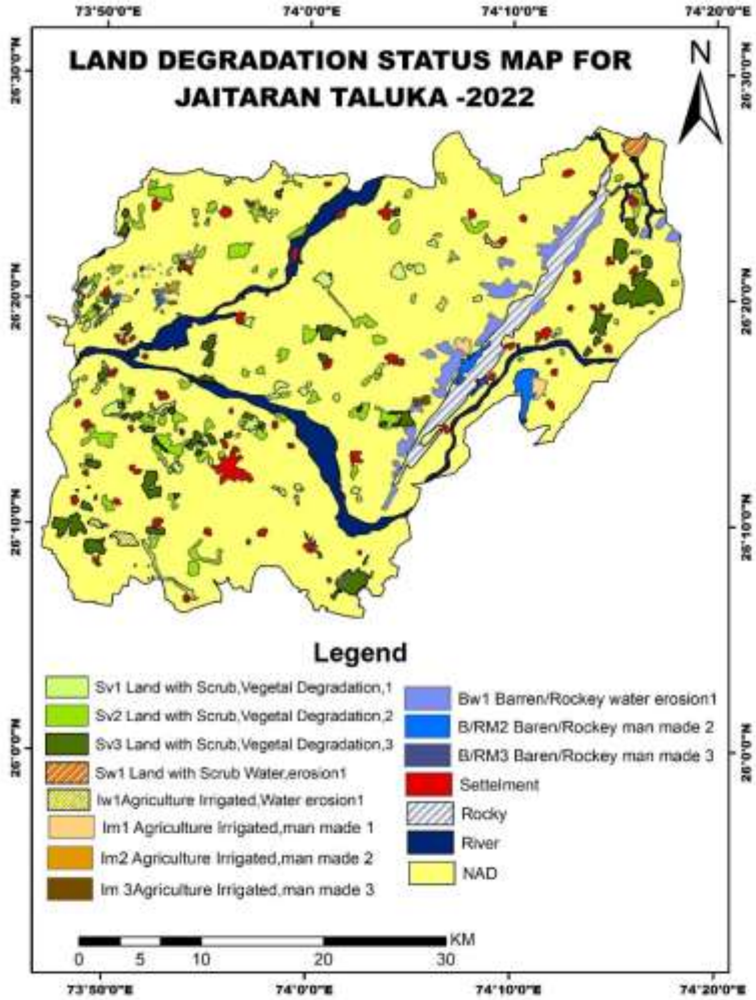

Figure 4. Land degradation status map of Jaitaran for 2022 using Sentinal-2 data

Table 3:Jaitaran taluka: Change in Land Degradation, 1994 and 2022

S.NO.	code	LD Classes	Area			
			1994		2022	
			km2	%	km2	%
1	Bw1	Barren land, Water erosion, slight	20.08	1.46	22.5	1.63
2	Iw1	Irrigated agriculture, Water erosion, slight	10.42	0.76	1.92	0.14
3	Sw1	Land with Scrub, water erosion, slight	4.00	0.29	2.99	0.22
4	Sv1	Land with Scrub, Vegetal degradation, slight	9.33	0.68	24.56	1.78
5	Sv2	Land with Scrub, Vegetal degradation, Moderate	50	3.63	47	3.40
6	Sv3	Land with Scrub, Vegetal degradation, Severe	35	2.54	39	2.83
7	Im1	Irrigated agriculture, Mining/Quarrying,	0.81	0.06	2.91	0.21

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		slight				
8	Im2	Irrigated agriculture, Mining/Quarrying, Moderate	0.00	0.00	0.98	0.07
9	Im3	Irrigated agriculture, Mining/Quarrying, Severe	0.00	0.00	1.75	0.13
10	B/Rm1	Barren/Rocky area, Mining/Quarrying, slight	0.00	0.00	9.60	0.70
11	B/Rm2	Barren/Rocky area, Mining/Quarrying, Moderate	0.00	0.00	4.28	0.31
12	S	Settlement	7.00	0.51	18.10	1.32
13	RA	Rocky area	56.42	4.10	43.00	3.13
14	R	River	58.00	4.22	50.00	3.63
15	NAD	No Apparent Degradation	1125	81.76	1108	80.49
	Total		1376	100.00	1376	100.00

Table 4.Process-wise Land degradation status in Jaitaran, Taluka

The total area under mining and quarrying has increased from 0.81 km2 in 1994 to 19.11 km2 in 2022. Limestone mining area in agricultural land during 2022 was 19.11 km2 (Fig. 4). Which is several times more than in 1995. Mining and quarrying are also affecting the surrounding agricultural area as the limestone dust gets deposited on the land and thus the land gets eroded. Mining destroys vegetation and causes extensive damage to the soil, environment, and biodiversity. To study the impact of mining on vegetation conditions, NDVI has been calculated for agricultural areas undergoing mining activities. After mining, the average NDVI value of the agricultural sector has decreased significantly (2022). The total land degradation in 1994 was 136.69 km2, which increased to 174.62 km2 in 2022. From 1995 to 2022, water erosion in wastelands has increased from 21.12 km2 to 25.67 km2 (Table 4). Water erosion in irrigated agricultural areas has increased from 1.55 km2 in 1991 to 10.42 km2. This can be attributed to improper farm management practices, low organic matter, and low nutrient availability. Table 4 shows that the area under water erosion in Thaluka has seen a decrease in 2022.

Vegetation degradation is another important process of land degradation in the research area. Vegetation degradation in scrublands has been mapped into three severity classes: low severity (SV1), medium severity (SV2), and high severity (Sv3). Land undergoing vegetative degradation increased from 94.33 km2 in 1995 to 112.00 km2 in 2022 (Table 1). In 1994, there was a vegetative degradation process in the area with a moderate severity (SV2) of 50 km2, followed by a high severity (SV3) of 35 km2, and a low severity (SV1) of 9.33 km2. At the same time, in 2022, the vegetation degradation process will be found in the area with the largest area: Medium Severity (SV2) 48 km2, High Severity (SV3) 39 km2, and Low Severity (SV2) 25 km2.Thus, during the period 1994–2022, the area under SV3 has decreased, and the area under SV2 and SV1 has increased. The settlement area has increased significantly from 1994 to 2022, from 7.00 km2 (1995) to 17.84 km2 (2022), due to population growth.

Conclusion

The desertification status map of Jaitaran Taluka (Pali district) has been prepared on a large scale (1:25,000) using Landsat-5 data from 1994 and Sentinel-2 data from 2022. Spatial information on desertification has been mapped on the basis of showing the status of the area, desertification, and its severity. To prepare plans for the mitigation of desertification, spatial information is needed, not only on desertification but also on its status and processes. Information about the types and their severity is also required. The desertification status map has been prepared after 28 years of information and monitoring assessments of the study area. Processes like vegetation erosion, water erosion, mining, and quarrying are taking place in the study area. Limestone mining and quarrying are taking place at a rapid pace, which is the major human-induced desertification process in the study area. Limestone mining and quarrying are being done in agricultural land and rocky areas, which has resulted in barren land and poor, shallow soil on agricultural land, which is affecting the health of the people living there. Mining of limestone in an agricultural area in 1994. There were 99 square kilometres discovered. In 2022, a total of 4.15 square kilometres will be developed. Mining

Was discovered to be negligible in the Rocky Mountains in 1994, but it will be 10.1 km in 2022. Mining has been found in the area.

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Declaration

There is no conflict between the authors for paper publishing

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