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Problem and Management of Wasteland and Land Degradation in Rajasthan: A Case Study of Ajmer District

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ABSTRACT: Geographically, the Rajasthan is the largest state of India. The mapping of degraded and wasteland, its distribution and district base statistics are very important for land resource assessment and management. This paper deals with the status of land degradation affecting different kind of soils and under different management options. The study further illustrates the regional example of the Ajmer district. The pressure on land resources has increased manifold with the increasing human and animal population. Rajasthan is severely affected by wind erosion (56%) and south-eastern part is affected by water erosion (42%) and salinity and sodicity (2%) affected area is scattered throughout the state. The area is characterised by a marked temperature range with strong diurnal variations, a typical phenomenon of the warm-dry continental climate. Desertification ranks among the greatest environmental challenge for the ecosystems in this region, and twelve districts of Rajasthan are already affected by severe desertification. Wind erosion is the major cause of soil degradation in western Rajasthan, whereas water erosion affects mostly south and eastern Rajasthan.

KEYWORDS: wasteland, land degradation, Rajasthan, Ajmer, population, desertification, erosion, resources

I.INTRODUCTION

Inspired by Africa's 'Great Green Wall' concept to combat desertification and land degradation, India on Saturday launched its own green wall project that will, through afforestation, cover roughly 1,400-km long and five-km wide green belt buffer around the Aravali mountain range, covering parts of Gujarat, Rajasthan, Haryana and Delhi.[1,2] The ambitious project will involve planting native species of trees and shrubs on scrubland, wasteland and degraded forest land, along with rejuvenating and restoring surface waterbodies such as ponds, lakes and streams. It will also focus on agro-forestry and pasture development to enhance the livelihoods of local communities. Besides preventing eastward expansion of the Thar Desert, the newly-developed forests in the proposed green belt will also act as a barrier for the dust coming from the western side of the country to Delhi-NCR. The five-km buffer zone of the entire Aravali covers 6.3 million hectares (Mha) of land. Total 2.3 Mha of land out of it is currently degraded. Most of the degraded land is expected to be restored through the green wall project, giving a big boost to India's overall goal to restore 26 million hectares of degraded land by 2030. It will also help the country achieve the national goal of creating an additional 2.5 billion tonnes of carbon sink in the next seven years.

"The Aravali Green Wall Project will not only increase the green cover and biodiversity of the Aravali, but also improve the soil fertility, water availability and climate resilience of the region," said environment minister Bhupender Yadav while launching the project at Tikli Village in Haryana. Yadav also said that the project will benefit the local communities by providing them with employment opportunities, income generation and ecosystem services.[3,4]

"Inspiration of the project comes from the Great Green Wall of Africa where African countries have jointly been implementing the project from Dakar (Senegal) to Djibouti as part of their goal to fight land degradation," said an official. He said the green belt in India may not be contiguous like Africa, but it would roughly cover the entire degraded Aravali range through multiple initiatives including afforestation. The project will be executed by various stakeholders such as central and state governments, research institutes, civil society organisations, private sector entities and local communities, he added.

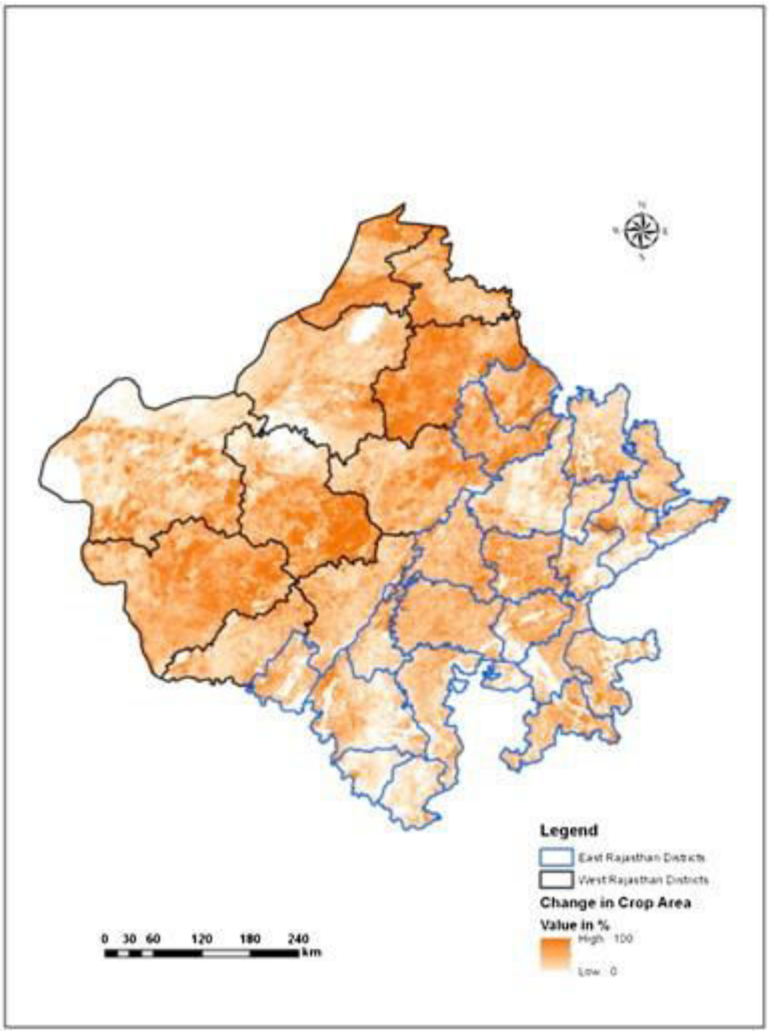
India has, at present, 96.4 Mha of degraded land which is 29.3% of the country's total geographical area (328.7 Mha). Isro's desertification and land degradation atlas of India shows that Gujarat, Rajasthan and Delhi are among the states/Union territories showing more than 50% of their respective areas under desertification and land degradation.
Shield Against Desert
*Districts to be covered by Aravalli Green Wall:
Delhi: Most part of degraded patches in the Capital
Gujarat: Banaskantha, Mahesana and Sabarkantha

Haryana: Bhiwani, Faridabad, Gurugram, Mahendragarh and Rewari
Rajasthan: Ajmer, Alwar, Banswara, Bharatpur, Bhilwara, Chittorgarh, Dausa, Dungarpur, Jaipur, Jhunjhunu, Karauli, Nagaur, Pali, Rajasamand, Sawai Madhopur, Sikar, Sirohi and Udaipur[5,6]
How will it benefit the country?
*Aravalli Green Wall will Protect NCR of Delhi from Sand and Dust storms and pollution
*To generate multiple environmental and socio-economic co-benefits
*Restore Degraded forest, crop and pasture lands;
*Sequester Carbon, Conserve Biodiversity
*Build Resilience to Climate Change
*Enhance Water Conservation, Agricultural Production and Farm Incomes in the Degraded most degraded land of India[7,8]

The pressure on land resources has increased manifold with the increasing human and animal population. Catering to the needs of a rapidly increasing population is a factor leading to encroachment on fallows and wastelands .The nature and causes of land degradation, and the degree and extent of damaged lands need to be determined, so that developmental agencies in participation with local stakeholders can proactively adopt measures to reclaim degraded lands for distancing food insecurity . Several agencies (National Commission on Agriculture 1976;Ministry of Agriculture 1978, 1985, 1994; National Bureau of Soil Survey and Land Use Planning -NBSS&LUP, 1994, 2004 and National Wasteland Development Board,1985) had estimated the area under degraded and wastelands at National level, but no one agreed to any estimates due to differences in the definitions of degraded land sand in the methodologies used. Therefore, NBSS&LUP has developed a harmonized methodology which is agreed upon by all working agencies for estimating the degraded and wastelands status in India including Rajasthan state. The extent and distribution of degraded and wasteland in different states of India is estimated in a GIS environment (ICAR, 2010). Geographically, the Rajasthan is the largest state in India. The mapping of degraded and wastelands, its distribution and district base statistics is very important for the state. The datasets on the kinds of land degradations, their spatial distribution are tabulated and mapped. The land resource inventory of Rajasthan is geo referenced and therefore can be used for precise land use planning as well as for strategic development of unutilized degraded and wastelands for some better purposes such as rehabilitation, village or community forestry development or special economic zones (SEZs) delineation. [9,10]

Location

Rajasthan state is located between 69°30' to 78°17' E longitudes and 23°30' to 30°12'N latitudes, covering about 34.22 M ha (342,239 km2); which accounts for 10.4% of the total area of the country (Fig.1) The state is bounded in the west by Pakistan, in the north by Haryana and Punjab, in the east by Uttar Pradesh and Madhya Pradesh, and in the south by Gujarat. The main geographic features of Rajasthan are the Thar Desert in the northwest and the Aravalli Range, which runs through the state from southwest to northeast, almost from one end to the other, for more than 850 kilometres.



Map of Rajasthan

II.DISCUSSION

Agriculture is the mainstay of India's economy. Land and Water, therefore, are of critical importance. Vast tracts of the land are, however, degraded but can be brought under plough with some effort. Redressing such lands, known as Wastelands, can be a powerful tool for attacking the issues of poverty and backwardness. This is being done through the Integrated Wastelands Development Programme, as a 100% Centrally Sponsored Scheme to be taken up on watershed basis. The Programme is taken up on a participatory mode with the involvement of local people and using low cost and locally available technologies.

Ministry of Rural Development has released an amount of Rs.41.48 lakhs for implementation of Central sector scheme Integrated Wastelands Development Project (IWDP) in Ajmer district of Rajasthan State. The funds are given to the District Rural Development Agency, Ajmer towards the expenditure, which will be incurred on implementation of wastelands development project during 2001-2002.

Land is an essential part of the supportive ecosystem of the Earth. Humans and animals are dependent on the ecosystem services, such as food, fiber, and shelter, provided by this natural resource [1]. Resource degradation is one of the hottest topics of research at present due to its alarming threat to biodiversity [2]. Land degradation is nothing but the unsustainable over-exploitation of resources resulting in decreasing productivity and capabilities to provide a set of ecosystem services [3,4]. The international forum United Nations Convention to Combat Desertification (UNCCD) reports the degradation of land resources to be a challenging concern [5,6]. Moreover, increasing food demand, anthropogenic activities, and changing climatic scenarios altogether put immense pressure on land resources, leading to degradation [7,8].

The agriculture system is a major pillar of global food security, but its productivity is currently threatened by various land degradation mechanisms, which are triggered by anthropogenic activities and climate change [9,10]. The frequency of extreme events caused by climate change is increasing the susceptibility of agricultural soils to degrading processes [11]. In Ajmer about 24% (about 3500 Mha) of the land area is affected by land degradation [12]. The severity of land degradation in Ajmer has been reported to be 94 Mha due to water erosion, 9 Mha due to wind erosion, 14 Mha due to waterlogging, 6 Mha due to salinity/alkalinity, and 16 Mha due to soil acidity [11,13,14]. Considering the increasing severity of degradation, Ajmer is working to restore about 26 Mha of degraded land by 2030 in accordance with the Bonn Challenge and United Nations' activities [15]. Ajmer district has a hot arid climate with low rainfall and high wind speed [16], comprising about 62% of the hot arid region of Rajasthan. Agro-climatic zones, such as the arid western plains (Barmer and part of Jodhpur) and the hyper-arid partially irrigated zones (Bikaner, Ajmer , Jaisalmer, and Churu), are the most highly prone areas to wind-erosion-assisted land degradation due to their climatic characteristics and sandy terrain in Rajasthan [17,18]. About 76% of the area of hot arid Ajmer district has wind erosion problems, where soil erodes at a high rate of 1.3 t ha^{-1} to 83.3 t ha^{-1} [19].

Assessments of land degradation vulnerability play critical roles in prioritization and planning for degradation neutrality and conservation policies [20]. Various important factors, such as topography, climate, soil, and land use patterns, need to be determined for the land degradation modeling and assessment of an area. Several techniques have been developed for the evaluation of land degradation, but geospatial techniques have replaced the time-consuming and costly traditional survey, especially in places that are difficult to assess [21]. High-resolution satellite imageries are capable of providing reliable and consistent insights into land degradation types, their rate, and resulting adverse impacts in a cost-effective manner in the Ajmer district of Rajasthan[22,23,24,25].

Land degradation is satisfactorily studied using numerous methods, such as machine learning models [20,21], GIS-assisted spatial analyses [24], time-series and trend-based analyses [22], soil loss and risk assessment models [23], and MEDALUS [24,25]. One of the most feasible options for assessing and mapping degraded land is the integration of the multi-criterion decision analysis (MCDA) method with geospatial techniques. This allows the complex problem to be broken down into sections followed by a solution and then the integration of each section to obtain the final result/solution. The Analytical Hierarchical Process (AHP), first developed by researchers, is one of the MCDA methods used in the mapping of degradation vulnerability [15,16]. AHP is a well-structured and widely accepted decision-making technique. Many researchers have used AHP and geospatial techniques for assessing and mapping land degradation vulnerability in the Ajmer district of Rajasthan [12,24].

Much research has been carried out on various land degradation, such as water erosion and gully erosion, but limited research has been carried out on the identification of wind-erosion-prone areas using AHP and geospatial techniques, particularly in the arid climate of Ajmer, Rajasthan. This study area is highly vulnerable to wind erosion due to its climate, soil, and geology. Despite this, no research has been carried out in this region to evaluate and develop a land degradation vulnerability map. Therefore, an integrated approach of AHP and GIS has immense potential to accurately estimate the wind-erosion-prone areas and identification of most priority areas for suitable erosion control measures. Hence, the objectives of the present study were as follows: (i) to characterize the vegetative, soil, climatic, and terrain parameters of the basin and (ii) to identify the area's most vulnerable to land degradation using AHP along with RS and GIS techniques. The results of the present study help to provide important information for soil and water management practices, land use plans, and environmental sustainability for the study area viz. Ajmer.[26]

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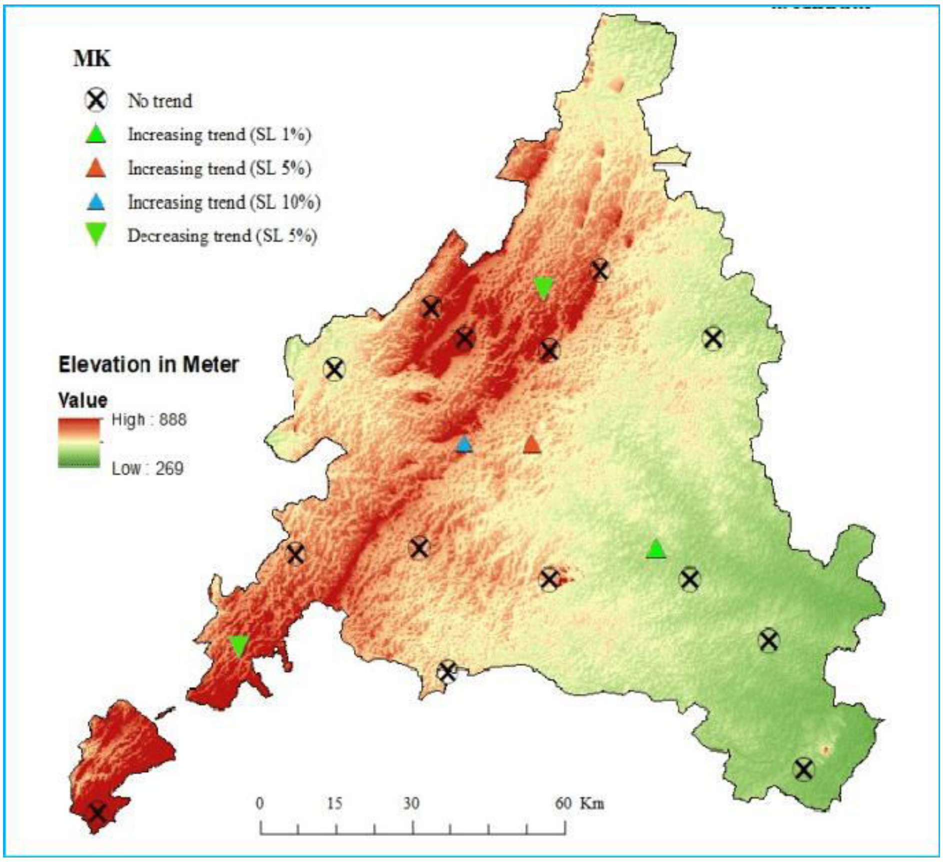

MK trend of annual rainfall of Ajmer district, Rajasthan

III.RESULTS

The mean NDVI values of the study area (Ajmer district) range from −0.03 to 0.60, and they were divided into five subclasses, viz., −0.03–0.19, 0.19–0.24, 0.24–0.29, 0.29–0.36, and 0.36–0.60 . The highest area (27.9%) falls under subclass −0.03–0.19, followed by 0.24–0.29 (27.4%), and the lowest area falls under subclass 0.36–0.60 (4.9%). The low NDVI class was assigned higher weights, while the high-value class was assigned lower weights [22]. The study of LULC established the baseline information for activities such as the thematic mapping and change detection analysis of earth over time. The study area's LULC map represents cropland (46.9%), current fallow land (21.2%), land with shrub/scrub (20.3%), forest (shrub/scrub/degraded) (1.4%), other wastelands (8.6%), built-up land (urban/rural) (0.5%), deciduous forest (0.8%), water bodies (0.5%), and gullied/ravines (0.01%). Most of the area (68.7%) is used for agriculture, which spread across the study area, mostly covering the northeastern and southeastern parts rather than the western part. Around 2.15% area of the river basin is covered by various types of forests, including deciduous and degraded forests, which lie in the southeastern part, and the central part of the Ajmer district is covered by land with shrub/scrub (20.3%).The study area is mainly composed of moderate soil erosion (56.3%), followed by severe erosion (35.2%), and very severe erosion occurs the least (4.2%). Severe and very severe erosion are mainly concentrated in the western part, and moderate erosion is found in the eastern part of the study area.[26] The soil in the study area was classified into different texture classes, namely, clay/fine loam, loamy skeletal, sandy skeletal, and sandy soils in Ajmer. The study area is mainly composed of sandy soil (49.5%), followed by clay loam (24.4%), with loam representing the least amount (1.1%). The western part of the study area is dominated by sandy soil, whereas the eastern part is dominated by fine loam and clay loam texture.[20,21]

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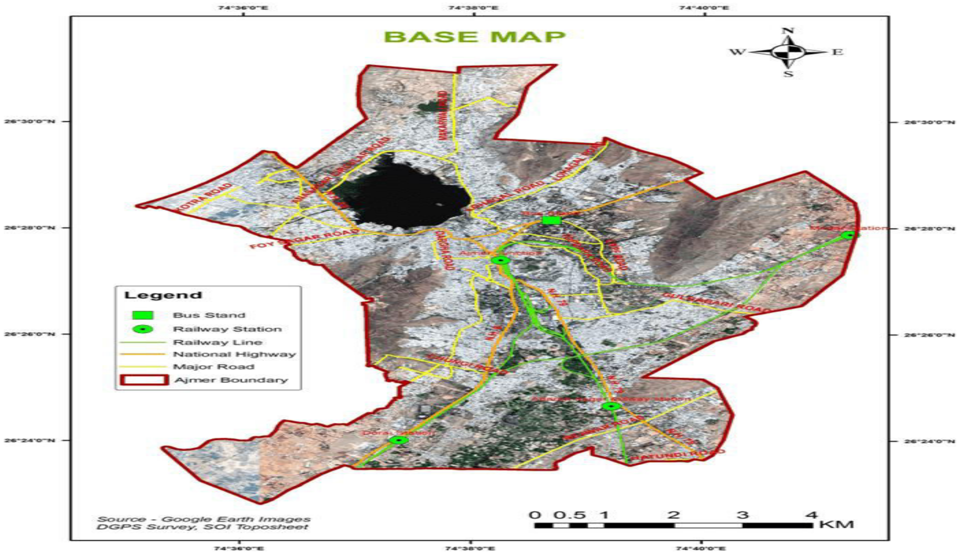

Ajmer district-map

IV.CONCLUSIONS

In the present study, nine thematic layers, namely, NDVI, LULC, rainfall, LST, slope, SOC, soil erosion, soil texture, and depth, were taken into consideration for LDVZ identification and mapping in the Ajmer district , Rajasthan.[23,24] The analysis revealed that 33.7% of the area falls under high to very high vulnerability, followed by 16% of the area falling under moderate vulnerability and 50.3% of the area falling under low to very low vulnerability. The validation of the LDVZ with Google Earth images and field photographs clearly showed that the remote sensing data combined with AHP adequately distinguished the sites prone to land degradation in the study basin in a cost-effective and time-efficient manner. Additionally, the ROC curve analysis, with an area under the ROC curve value of 82%, validated the AHP method’s potential to accurately estimate the LD vulnerability zones in the research area. Soil and water conservation structures that are appropriate could be suggested for the regions that are extremely and very highly prone to LD. Multi-criteria decision analyses and geospatial techniques can be used as tools for prioritization management in order to achieve LD neutrality in arid and semi-arid regions.[25,26]

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