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Land Degradation Mapping in Chickmagalur District of Karnataka using Remote Sensing Technique

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Abstract

The present study on land degradation mapping of Chickmagalur district of Karnataka state was aimed at ascertaining the status of degradation, its nature, extent and spatial distribution with the ultimate objective of providing location specific data base for taluka and district level planning. The study reveals that nearly 2.3% of the total geographical area of the district is under various categories of degraded lands comprising water erosion, salt encrustation (salt affliction) and land dereliction due to open cast mining. Severe and very severe soil erosion is the main degradation problem. The various categories of land degradation identified through rapid inventory would serve as the primary input in formulating strategic plan for development of degraded lands of the district. However, detailed investigations of the degraded land using larger scale base map are warranted for assessing the degree of degradation for site specific developmental planning.

Introduction

In order to generate realistic information on degraded lands in the country, the Ministry of Agriculture, Govt. of India initiated the land degradation mapping using remote sensing during 8th Five Year Plan. The district based land degradation mapping on 1:50,000 scale using remote sensing techniques has been operationalised by the All India Soil & Land Use Survey (Dept. of Agri. & Coopn.) in selected districts covering various agro-climatic zones of the country (Das and Saini, 1998; AISLUS, 1998a,b,c). The land degradation mapping has been conceptualized as a four-tier approach comprising kind of degradation; degree or severity of degradation and degradation under major land use and landform. It will allow to abstract information on various kinds of degraded lands with spatial distribution under major land use and landform that will facilitate location specific planning towards development of degraded lands.

Study Area

Chickmagalur district of Karnataka State is situated in the southwestern part of the state. A major portion of the district is hilly, highly undulating covered with forest vegetation with heavy rainfall. The geographical area of the district is about 7.2 lakh ha and situated between 12° 10' to 13° 55' North Latitude and 75° 6' to 76° 22' East longitude and covered by the Survey of India toposheets No. 48 0/2, 0/3, 0/4, 0/5, 0/6, 0/7, 0/8, 0/9, 0/10, 0/12, 0/13, 0/14, 0/15, 0/16, 48 P/9, 57 C/1, C/2, C/3, C/4 and C/6 on 1:50,000 scale. The district is divided into two sub divisions viz. Chickmagalur and Tarikere. Index map of Chickmagalur district of Karnataka State is shown in fig. 1.

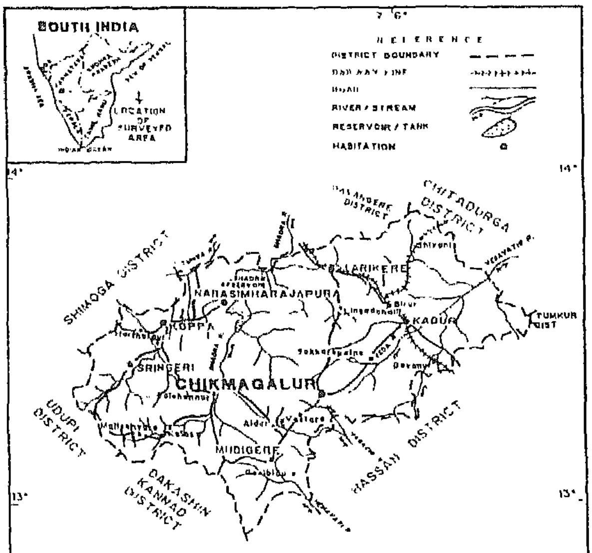

FIG. 1. INDEX MAP OF CHIKMAGALUR DISTRICT KARNATAKA

SCALE = 1 : 1 000 000

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Fig. 1 Study Area

The climate of the district is subhumid to semi arid, the rainfall generally varies from 549 mm to 5157 mm. There is rapid increase in the temperature after February, April is generally the hottest month with daily maximum temperature of 35.7°C and mean daily minimum temperature of 16.1°C. The day temperature begins to decrease after August. However, the nights become progressively cooler after August.

The large part of the district is hilly to highly undulating. There is a formidable ghat range in the western part of the district. The highest peak is about 1898 m above M.S.L. A large portion of the district amounting 86% of the total area falls under Krishna basin, while the Cauvery basin covers 8.4 % and rest flowing rivers cover 5.6%. The principal rivers of this district are the twin streams, the Tunga and Bhadra, the later running most of its course in this area. The drainage pattern is dendritic to subdendritic with medium to high drainage density. The district is made up entirely of *Archean schists and gneisses*. The Dharwar schists occupy 50% of the area of the district and occur in three well defined belts namely (I) the Kudremukh-Gangamola (ii) the kappa and (iii) the Baba-Budan belt. The soils of the area are heterogeneous in characteristics largely owing to variation in parent material, physiography, relief, climate, biotic factors, land use and management. The difference in relief is responsible for variation in soil moisture condition, drainage condition and erosion etc., which ultimately lead to the formation of different types of soils in the area.

Materials and Methods

The approach adopted to extract the desired information involved monoscopic analysis of remote sensing data following standard usual image interpretation techniques. Discrimination of various degraded lands based on image characters was made, delineated and symbolized as per legend (NRSA, 1985) followed by ground verification. Various steps involved are described below:

1. *Selection and procurement of imagery*: The identification and mapping of degraded lands using remote sensing technique data product calls for selection of season/period of data acquisition. A combination of two seasons namely post monsoon season and summer season images afford to identify most of the degraded lands and land use/ land cover with fair degree of delineation. As for quality and format of data used, the geocoded cloud free false colour composite (FCC) data of IRS-1A - LISS II (Band 2, 3 & 4) being supplied by National Remote Sensing Agency, Hyderabad (AP) on 1:50, 000 scale were procured and used.

2. *Preparation of base map* : Base map was prepared on drafting film deriving information on land use limits, cultural features, drainage and coordinates from Survey of India toposheets on 1:50,000 scale.

3. *Prefield interpretaticn* : Interpretation of image was carried out in two stages for abstracing information on various degraded land units by analyzing two-season imagery in consultation with topographical map. Monoscopic visual interpretation technique based on image characteristics/elements i.e. colour, tone, texture, patterns, shape, size, association etc. enabled to identify and delineate different land degradation units and accordingly image interpretation key was developed. Analysis of images was carried out in succession using the interpretation key.

4. *Ground verification* : To confirm the identification and delineation of different degradation types and normal lands field checks were undertaken in a planned way. Taking cognizance of heterogeneity and distribution of various degraded and normal lands, selected sample strips were checked with regard to correct identification and delineation of units was established. Considering the heterogeneity and trafficability about 30% of the district area was checked on the spot in respect of various degraded land units identified and delineated, relevant image characteristics, causative factors and ground conditions of the map units were recorded.

5. *Post field interpretation* : Image analysis carried out prior to field check was thoroughly examined and adjusted in the light of ground information collected and established image-ground feature relationship. The delineation of each unit was finalized successively.

6. *Evaluation and area measurement* : The validity of units was further tested by carrying out random checks during field review and necessary corrections were made with regard to identification and delineation of units and maps were finalized. The extent of individual map unit was measured plannimetrically after taking out a print of individual sheet. The area under various degraded lands is given in table 1.

Table 1. Nature, extent and percentage of degraded lands in the district

S. No.	Mapping symbol	Description	Area in area	Percentage
Water Erosion				
1.	Welal	Severe water erosion, plain, agriculture	54	0.01
2.	Weldl	Severe water erosion, hilly, agriculture	8	0.01
3.	We2al	Very severe water erosion, plain, agriuclture	2000	0.03
4.	We1/Sa1al(4)	Severe water erosion and moderately saline, plain, agriculture, changed to other lands.	94	0.05
5.	We2/Sa1b1(4)	Very severe water erosion, moderately saline undulating, agriculture, changed to other lands	499	0.07
6.	We2/Sa2b1(4)	Very severe water erosion and strongly saline undulating, agriculture, changed to other lands	60	0.01
7.	Sa1b1(4)	Moderately saline undulating, agriculture, channged to other lands	1484	0.21
8.	We1d2	Severe water erosion, hilly, forest	10266	1.42
9.	*We1d2	Severe water erosion, hilly private forest	1107	0.15
10.	Ls1d2	Land slides, hilly, forest	15	0.01
11.	Mn1d2	Open cast mine, hilly, forest	176	0.02
12.	Web4(1)	Severe water erosion undulating, other lands, changed to agriculture	107	0.01
13.	We1a4	Severe water erosion, plain, other lands	55	0.01
14.	We1b4	Severe water erosion, undulating other lands	86	0.01
15.	We1b4	Wevere water erosion, hilly, other lans	276	0.04
16.	We2a4	Very severe water erosion, plain, other lands	13	0.01
17.	We1/Sa1a4	Severe water erison and moderately saline, plain, other lands	123	0.01
18.	We2/Salb4	Very severe water erosion, moderately saline, plain, other lands	505	0.07
19.	Sa1a4	Moderately saline, plain other lands	125	0.01
20.	Mn1d4	Open cast mine, hilly, other lands	150	0.02
21.	Mn1d4	Open cast mine, hilly, other lands	18	0.01
22.	We1d3	Severe water erosion, hilly, plantation	16	0.01
23.	Sa1a3	Modertaely Saline, plain, plantation	301	0.04
		Sub-total A	16038	2.26
Non-Degraded Lands				
24.	1	Agriculture	2,07,386	28.71
25.	1(3)	Agriculture, changed to plantation	11,585	1.60
26.	2	Forest	1,62,725	22.54
27.	*2	Private forest area	1,24,085	17.18
28.	2(1)	Forest, changed to agriculture	4,909	0.68
29.	*2(1)	Private forest changed to agriculture	2,515	0.35

30.	4	Open scrub	64,277	8.90
31.	4(1)	Open scrub, changed to agriculture	3,644	0.50
32.	4(1)	Open scrub, changed to plantation	1,556	0.22
33.	3	Plantation	1,02,562	14.20
34.	3(1)	Plantation, changed to agriculture	1,332	0.18
35.	3(4)	Plantation, changed to open scrub	216	0.03
36.	H	Habitation/roads and others	711	0.09
37.	R	River/Water bodies/reservoirs/tanks	18,531	2.56
		Sub-total B	7,06,034	97.74
		Grant total (A + B)	7,22,072	100%

Table 2. Land use and land degradation types

S. No.	Land use	Land degradation type (Area in ha)							
		Severe water erosion	Very severe water erosion	Water erosion with salt affliction	Very severe water erosion with salt affliction	Salt afflictin	Land slide	Open cast mining	Total
1.	Agriculture	62	200	394	559	1489	-	-	2699 (0.38%)
2.	Forest	10266	-	-	-	-	15	176	10457 (1.46%)
3.	Open scrub under Agri.	107	-	-	-	-	-	-	107 (0.01%)
4.	Open scrub	417	13	123	505	125	-	150	1058 (0.19%)
5.	Plantation	16	-	-	-	301	-	-	317 (0.05%)
6.	Private Forest	1107	-	-	-	18	-	-	1125 (0.17%)
	Sub Total	**11975**	**213**	**517**	**1064**	**1910**	**15**	**344**	**16038 (2.26%)**
Normal land									686792 (95.09 %)
River and reservoir									18531 (2.56%)
Habitation									711 (0.09%)
	Grand Total								**722072 (100%)**

Results and Discussion

During investigation five types of land degradation were identified in the district i.e. water erosion 12188 ha (1.69%), salt affliction 1910 ha (0.26%), water erosion with salt affliction 1581 ha (0.22%), open cast mine with spoils 344 ha (0.05%) and land slide 15 ha (0.01%) (Table 2). Out of 7.22 lakh hectare area of district 2.07 lakh (28.71%) area of agriculture was normal. Forest area of 1.63 lakh hectare (22.54%) was normal whereas 4909 ha (0.68%) area of forest changed to agriculture. Open scrub area 64277 ha (8.3%) was normal, 3644 ha (0.5%) of open scrub changed to agriculture, 1556 hectare (0.22%) of open scrub changed to plantation.

Table 3. Topographical distribution of land degradation

S. No.	Land use	Land degradation type (Area in ha)								
		Severe water erosion	Very severe water erosion	Severfe water ersiont with salt affliction	Very severe erosion with salt affliction	Land slide	Open cast mind	Salt affliction	Total	%
1.	Plain	109	213	517	-	-	-	1910	2749	0.30
2.	Undulating	193	-	-	1064	-	-	-	1257	0.18
3.	Hill	11673	-	-	-	15	344	-	12032	1.69
	Sub-Total	11975	213	517	1064	15	344	1910	16038	2.26
	Normal land								686792	95.09
	River and Reservoir								18531	2.56
	Habitation								711	0.09
	Grand Total								722072	100%

Plantation area of 102562 hectare (14.20%) was normal, 1332 hectare (0.18%) of plantation changed to agriculture and 216 ha (0.03%) of plantation changed to open scrub.

The habitation and rivers covered 711 ha (0.90%) and 18531 ha (2.56%) area, respectively. The extent of land use wise distribution of degraded land is presented in table 2.

The topographical distribution of land degradation data (Table 3) shows that 2749 ha (0.39%) area was degraded in plains, 1257 ha (0.18%) area was degraded in undulating land and 12032 ha (1.69%) were degraded in hills.

It was observed that out of 722072 hectare of the district, 16038 hectare suffered from land degradation problem. The major problem found in the district was water erosion and salt affliction. It had serious adverse effect both on soils in terms of reducing productivity and off site effects in term of environmental degradation. This also pointed out that 11785 ha area of the forest was degraded due to water erosion.

Conclusion

Rapid inventorying of degraded lands using remote sensing techniques provides the realistic information that form the basic input for formulating district level planning towards development of degraded lands. The extent of various kinds of degraded lands with their spatial distribution in the district besides their distribution under different land use, landform as well as on talukawise could serve as the primary level inputs for development planning of degraded lands. Above all it will be the base for monitoring of the status of degraded lands in the district. However, detailed acquisition of soil information pertaining to degraded land is essential for location specific planning to undertake rehabilitation measures and to bring them back under production system.

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