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Research Article

LAND RESOURCE INVENTORY, SOIL MAPPING FOR CONSERVATION MEASURES – A REMOTE SENSING BASED APPROACH

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ABSTRACT
Land degradation and erosion is the greatest problem being faced by the mankind due to his own activities. To minimize land degradation and soils erosion, numbers of measures are being taken by various agencies. The estimated soil loss at the rate of 5,334 million tones of top soil in all over India has put forth a mammoth task of conservation measures on over footing. Land resources inventory and identification of soil problems forms a prerequisite in the selection of suitable conservation measures. With the advent of Remote Sensing technique, this task of natural resources inventory and identification of soil problem is becoming a easier than the conventional methods. The present paper on Dhand watershed of Khuldabad tahsil, Aurangabad district, Maharashtra (India) primarily deals with land resources inventory, soil mapping, their problems and potentials and suggestion of conservation measures using integrated approach with the help of Remote Sensing data in conjunction with collateral data. On the basis of Remote Sensing data and collateral data slope, land use/land cover, hydro-geomorphology, soil and its related problems were identified and analyzed integratedly. Soil and water conservation measures (like mechanical, trenching, contour bunding, gully plugging, vegetative, etc.), cu were suggested to restore the eroded area on sustainable basis. It has been observed that soil problems and hydro-geomorphic unit with ground water prospects gives more realistic approach for arriving site specific soil and water conservation measures.

Key Words: *Land Resource Inventory, Soil Resource Mapping, Soil Erosion, Soil Conservation, Remote Sensing Approach*

INTRODUCTION
Land is continuously under treat of degradation and erosion due to various reasons. In India, total of 148.9 million ha of land, representing 45% of the total geographical area is subjected to soil erosion and land degradation (Sehgal and Abrol, 1994). On account of various forms of degradation, it has been estimated that the loss of 5.334 million tonnes of top soil occurs annually, which is equivalent to 5.37 to 8.4 million tonnes of plant nutrients (Dharuvanarayana and Rambabu, 1983). The loss of top soil and run-off loss is specially more in an area covered with meagre vegetation/forest cover. Beside this, the human population explosion in the pursuit of meeting the fuel and fodder demand indiscrimitates destroy vegetation cover and such situations get further aggravated in drought prone areas, receiving rainfall less than 750 mm. In Maharashtra State about 35.2% of area is identified as drought prone covering 89 tahsils of 13 districts. In these areas, an imperative stage has come where suitable soil and water conservation measures are immediately warranted so as to reduce soil erosion and land degradation. With the general acceptance of watershed as principal unit of planning of all developmental activities based on suitable utilization of locally available natural resources, hence the watershed requires the detailed characterization and inventorization of natural resources (Patil *et al*, 2010 ; Manchanda *et al*, 2002**)**. Mapping and assessment of erosion prone areas is pre-requisite for planning soil conservation and watershed management programs (Surya *et al*, 2007) and several studies reported potentials use of remote sensing for characterization and management of land resources at watershed level (Srinivasa *et al*, 2008; Elvis *et al*, 2009; Solankhe *et al*, 2009). Therefore for better understanding of land resources, its

problems/potentials is of vital importance and thus, the present study was carried out to generate the natural resources inventory, soil and water related constraints and to suggest location specific conservation measures needed for management of natural resources of the tahsil/watershed.

MATERIALS AND METHODS

The study area, Dhand watershed, Khuladabad tahsil is located on the Northern side Aurangabad district of Maharashtra. It covers an area of 82 sq. km. About 10 villages are falling in the study area. Climate is hot semiarid with mean annual rainfall of 650 mm. Area qualifies ustic moisture regime and hyperthermic soil temperature regime. The Length of Growing Period (LGP) in the watershed varies from 90 to 120 days. The area is drained by Dhand river and its tributaries. Entire watershed is underlined by Deccan Trap. Majority of area under cultivation of single crop, double cropping is mainly restricted along the river valley.

The satellite imageries, Geo-coded IRS- IA LISS II were visually interpreted for land use/ land cover, hydro-geo-morphology, slope, drainage based on tone, texture, size, association etc. The ancillary data namely Survey of India (SOI) topographical sheets on 1:50,000 scale and district administrative maps, were used as reference materials. The soil mapping of Dhand watershed was done with support of remote sensing satellite images adopting visual interpretation procedure on 1:50,000 scale. Soil profile studies, soil correlation and classification were carried out by using standard procedures. Soils were correlated and classified as per Soil Taxonomy (Soil Survey Staff, 2000). The soil erosion status, irrigability class (AIS & LUS, 1971) and soil problems were identified and evaluated. The thematic information on various themes *viz.*, slope, drainage, land use/land cover, hydrogeomorphology, soil, etc. on the scale of 1:50,000 scale were generated. The collateral data base containing crops and cropping pattern, dug well density, socio-economic data, etc. for Dhand watershed have been collected from respective sources. By integrating these information suitable conservation measures were suggested.

RESULTS AND DISCUSSION

Resource characterization

Slope: The general slope of Dhand watershed is towards S to SE direction. Based on the density of contour on toposheets, seven slope classes have been identified. The most dominant slope category of 0-1% occupy 38 sq km of TGA followed by 1 – 3% (18 sq km) and the higher slope categories of 10% and above occupying 11 sq. km.

Land use /land cover: Major land use of the study area is under cultivation of single crop. Agricultural practices with dominance of *Kharif crops* like cotton, pulses and bajra, with sprinkle of sugarcane in the irrigated areas. In *Rabi* season, wheat, sunflower are sown. Double cropping is observed all along the Dhand River (Fig. 2). The area mainly irrigated by minor irrigation project and also on ground water resources. Forest (dense deciduous forest and open deciduous forest) and scrub lands were seen over higher slopes.

Hydrogeomorhology: Entire watershed is underlined by Deccan Trap formation over which various geomorphical process resulted into moderately dissected plateau (A,B & C zones), plateau tops, denudational hill and denudational slopes. Among these moderately dissected plateau (MDP) 'C' zone is most predominant (37 sq. km.) followed by moderately dissected plateau 'B' zone and Denudational slopes. The groundwater potential has been assessed considering weathered thickness of each zone and the available observation well data. The MDP 'C' zone has good while MDP'B' and PT have moderate groundwater potential and MDP'A' and Denudational hill have poor ground water potential.

Soil resources:

The soil resource characterization and mapping was done on 1:50,000 scale for identification soils, assessment of soil erosion status, evaluation of soil irrigability class and identification of problems and potential areas. In total, 11 soil series have been mapped with associations of soil series. But the dominant series are taken into consideration for integration purpose. Soil series and its major problems,

Table 1: Details of soil series, its problems, hydrogeomorpholgy, and ground water potentials with suggested measures

Soil Series	Erosion	Irrigability class*		Soil problems	Geomorphic Unit	Hydrological grouping	Groundwater potentials	Conservation measures**
		Soil class	Land Class					
Arangaon Series	Slight to moderate	B	2	High clay content, somewhat restricted drainage, high swell-shrink problem	MDP 'C' MDP 'B'	Moderate run-off potential	Good to Very Good	CNB Series ENB
Antarwadi Series	Slight to moderate	B	2	High clay content , somewhat restricted drainage, high swell-shrink problem	MDP 'C' MDP 'B'	Moderate run-off potential	Good to Very Good	UGB, KTW, CNB ENB.
Mahakala Series	Slight to moderate	B	2	High clay content , somewhat restricted drainage	MDP 'C' MDP 'B'	Moderately high run-off potential	Good to Moderately Good	ENB, CNB Series GP
Shivgud Series	Moderate	C	3	Gentle slopes	MDP 'C' MDP 'B'	Moderately high run-off potential	Good to Mod. Good	CNB Series GP, ENB, PT
Walkeshwar Series	Moderate to severe	B	3	Gentle slopes	MDP 'C' MDP 'B'	Moderately high run-off potential	Moderately Good to Moderate	CNB, UGB Series CNB
Dudhapur Series	Moderate to severe	C	3	Gentle slopes	MDP 'C' MDP 'B'	Moderately high run-off potential	Moderately Good to Moderate	UGB, CNB Series
Khedgaon Series	Moderate to severe	D	4	Mod slopes, severe erosion	MDP 'B' DS	Moderately low run-off potential	Poor to moderate	ENB, Series GP, CCT, VB
Deshgavan Series	Moderate to severe	C	4	Mod slopes, severe erosion	MDP 'B' MDP 'A'	Moderately to high run-off potential	Poor to moderate	ENB & GP Series
Taka Series	Moderate to severe	D	4	Mod slopes, severe erosion	MDP'B' 'A', DS, PT	High run-off potential	Poor, Poor to moderate poor	UGB, CNB CCT , GP, VB
Khuldabad Series	severe	E	6	Very shallow to shallow depth	MDP 'B' DH, DS, PT	High run-off potential	Poor, Poor to moderate poor	GP, ENB Series CCT, CNB
Sala-Pipalgoan Series	severe	D	6	Mode slopes, severe erosion	DS, DH	High run-off potential	Poor	GP, CCT Series, VB

***Irrigability class**: **Soil class for sustained use under irrigation**: B- Mod. soil limitations; C- Mod. to severe soil limitations; D-Very severe soil limitations; E-Not suited for irrigation; **Land class for sustained land under irrigation** :2- Mod. limitation; 3-severe limitations; 4- Marginal limitations; 6- Not suited for sustained land under irrigation.*

***Conservation measures**: GP- Gully plugs; UGB-Underground Bandharas/Bunds; PT- Percolation Tank; KTWeir- Kholapur Type weir; ENB.- Earthen nalla Bunds; CNB- Cemented nalla Bunds; C.C.T.- Continuous Contour trenching; VB- Vegetative bunds*

erosion status, irrigability class related to soil and land class and hydrological groupings are tabulated in table-1. The various soil series are briefly described below:-

* The Arangaon and Antarwadi series occupied 23.3 and 2.18 %. of TGA, respectively, mainly along the Dhand river and its tributaries where drainage double cropping is being practiced. These soils are classified as Fine, montmorillonitic, isohyperthemic Typic Haplustert. These soils series have high water holding capacity and susceptible to slight to moderate erosion hazards. These soils have moderate soil limitations for sustained use under irrigation (soil irrigability class B) and moderate limitation for sustained land under irrigation (Land irrigability class-2). The major problems of these series is high clay content, high water holding capacity and high shrink-swell potential. In hydrological grouping of these soils have high run-off potentials.
* Khedgaon Series (Coarse loamy, mixed, isohyperthemic Typic Ustorthent) is second dominant series occupies an in watershed (22.65 %). This soil series is under moderate to severe erosion hazards with shallow soil depth, well drained soils. Depth of soil and erosion is the major limitation of these soils. Moderately low run-off potential is the hydrological group with very severe soil irrigability limitation for sustained use under irrigation.
* Taka series, the third largest series occupy an area of 14.380 sq.km (17.5 %) and classified as Loamy, skeletal, mixed, isohyperthemic Lithic Ustorthent. These soils have low water holding capacity and moderate to severe erosion hazards. These soils are under irrigability soil and land class D & 4 respectively. The hydrological grouping of these series is under moderately high run-off potential.
* Shivgud Series (Fine, mixed, isohyperthemic Vertic Ustopepts) are moderately deep soils over gentle slopes of lower plateau and occupy 11.5 % area of Dhand watershed. Presently they are under single crop. These soils have low water holding capacity and have moderate erosion hazards. The hydrological grouping these soils comes under high run-off potential zone.
* Khuldabad series (Loamy, skeletal, mixed, isohyperthemic Lithic Ustorthent) occurs in the upper reaches of the watershed and occupied an area of 9.58% of TGA. These soils are occurring over steep slopes interspersed with rock-out crops and hence have low water holding capacity and prone to excessive erosion. The cultural use of these soils restricted to scrub lands and forestry . Very shallow depth, slope and erosion are the major problem of these soils. Soil irrigability class these soil is under non-irrigable soils with high run-off potential zone.
* Dudhapur series (Fine loamy, mixed, isohyperthemic, Typic Ustorthent) occurs in middle reaches of watershed and occupied an area of 3.38 sq.km (4.12%). These soils have moderate water holding capacity and are susceptible to moderate to severe erosion. Presently under single crop is been taken over this soil series. The major problem of soil is erosive slopes and moderately low run-off potential.
* Walkeshwar series (Fine, mixed, isohyperthemic, Vertic Ustropepts) occurs in local valleys of watershed and occupied by 3.85 % area. These soils have moderate water holding capacity and are susceptible to moderate to severe erosion hazards. Presently these soils are under cultivation of double and single crop. In hydrological grouping, these soils have moderately high run-off potential.
* Sate-Pipalgoan series classified as Coarse loamy, mixed, isohyperthemic, Typic Ustorthent occupies 2.12 % area of the watershed. These soils have moderate water holding capacity and are susceptible to severe erosion. Presently under single crop is been taken over this soil series. These soil major problem of moderate slopes and low run-off potential.
* Deshgavan series (Fine loamy, mixed, isoheperthemic, Fluventic Ustrothent) occupied 1.98 % area of watershed. They are over gentle to moderately sloping stream banks and local valleys having low water holding capacity and susceptible to severe erosion hazards. These soils are under scrub land and partly cultivated for single crop. Moderate slope and severe erosion are the major problems of these soils. According to hydrological grouping it has moderately low run-off potential.
* Mahakala series (Fine loamy, mixed, isohyperthemic Typic Ustropepts) occupied an area of 1.91 % which is under moderate erosion hazards. Presently these soils are under single and double crop. The soil Irrigability class for Mahakala soil is B and land Irrigability class is 2. In hydrological grouping of these

soils are under high run-off potential. The high clay content and high shrink/ swell potential is the major problems of these soils.

Soil and Water Conservation Measures

The various soils, their characteristics and its problems call for different locale specific soil and water conservation measures. The information thus generated was integrated to and suitable conservation measures were suggested (Table 1). Such integrated approach is well acknowledged at various levels and expected to yield better results in soil and water conservation than in single line approach. The various structures recommended in Dhand watershed area are –

In the upper reaches, shallow soil having severe to moderate erosion condition and high run-off potential are existing. In such area single cropping or scrub land is observed. These areas require measures like gully plugging, nala bunding and continuous contour trenching. Cultivation across slope, restricted cultivation with monocots, vegetative bunds, contour vegetative hedges, plantation activities is also needed to reduce soil erosion.

In the middle reaches, where soil is moderately thick with moderate erosion prone and moderate erosion with moderately high run-off potential, conservation measures like nala bunding and percolation tanks are required to reduce soil erosion and increase soil moisture. Over such area, the current agriculture practice is single cropping. Cultivation across slope, land leveling, vegetative bunds, crop rotation and mixed cropping is essential in such areas to reduce soil erosion.

In the lower reaches, where soil is deep to very deep having slightly to moderately erosion prone and low runoff to high runoff, various measures like nalla bunds. Underground bandharas and Kolhapur type weirs are required mainly to harness surface water and conserve groundwater. Such areas are experiencing high ground water exploitation, hence measures like underground bandharas and KT weir would be useful to arrest the sub-surface flow. Over such areas adoption of alternate beds and farrows, crop rotation and mixed cropping, drip irrigation are recommended to facilitate irrigation.

Conclusion

Problems related to soil and water are interrelated for which an integrated approach is necessary to arrive at definite action plan for soil and water conservation such planning calls for a holistic approach towards watershed management. The Remote Sensing techniques is one of the best tool in integrated approach as it provide spatial data base of Natural resources and its related problems. From the case study of Dhand watershed it can be concluded that soil problems such as soil erosion, soil and land irrigability class, hydrological grouping and, integrated with hydrological groupings and groundwater prospects gives more realistic approach for recommending site specific soil and water conservation measures because all these themes consider surface and sub surface characteristics of watershed.

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