SHORT NOTE

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SITE SUITABILITY ANALYSIS FOR SOIL AND WATER CONSERVATION STRUCTURES

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It is universally recognized that conservation of natural resources should be essentially on area basis and the unit of its adoption is a natural unit draining runoff water to a common or particular point called as watershed. The integrated watershed management is a multidisciplinary approach for rational utilization of natural resources existing in the watershed for optimum and sustained production with minimum hazards, considering holistic development for all users of watershed. It essentially relates to management of resources which means proper land use, protection of land against all forms of degradation, enhancement and maintenance of soil fertility, conservation of water for watershed use, flood protection, sediment reduction and improvement of productivity from all land uses.

In rain-fed areas, a small additional increment of water can dramatically increase crop yields and lower the risk of crop failure. Sometimes, it can make a difference between crop and no crop in drought areas. The objective and technologies of soil and water conservation are highly location specific and an appropriate technology developed for a particular region cannot be used as such for the other areas for physiographic, environmental, technical and socio-economic reasons. So far soil and water conservation, technologies are not based on annual rainfall only; but terrain, soil permeability and landuse on its variation in space and time too plays an important role in determining the sites.

Recent advances in remote sensing and GIS provide very useful information in undertaking the integrated resource analysis. Satellite remote sensing provides a reliable and accurate information on natural resources, which is pre-requisite for planned and balanced development at watershed level (Ravindran *et al.*, 1992). These two new technological tools have emerged to meet ever-increasing demand for more precise and timely information. An integrated element of generating map information is a combination and comparison of a variety of data derived from different sources such as remotely sensed imagery, ground surveys and existing topographic and other maps (Chagarlamudi and Plunkett, 1993). Integrated resource survey at watershed level with the help of remotely sensed data field surveys provides knowledge on the potential and limitations in resources planning and utilization, which is essential for formulating and execution of management strategies.

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Singh *et al.* (1996) and Behera and Mohapatra (1996) have carried out the studies on the application of remote sensing techniques for suggesting suitable sites for soil and water conservation measures in the various watersheds in the country. Chandra Sekhar and Rao (1999) suggested suitable sites for various water harvesting structures, likes Farm Ponds, Check Dams, Bundies for a sub-watershed of Song River in the Doon Valley of Uttaranchal. Thus, The Integration of Remote Sensing and GIS Techniques is a powerful spin-off from space exploration and it has emerged as a powerful tool for watershed characterization, conservation planning and management in recent times (Saraf and Choudhary, 1986).

In the present study of Hire Watershed in Koppal district of Karnataka state, an integrated approach of Remote Sensing and Geographical Information System (GIS) Techniques was used to identify runoff potential zones and further suitable sites for soil and water conservation structures such as contour bunding/land leveling, farm ponds, gully plugging, percolation tanks/nala bunds etc. The study area is lying between the latitudes of 15°39′50″ N to 15°57′59″ N and longitudes of 76°02′ 32″ E to 76°13′24″ E (Fig. 1). The total geographical area of the watershed is 180.82 km^2. The mean maximum temperature of the area is 39.6 ^{0}C in the month of May, while the mean minimum temperature is 18 ^{0}C in December. The average annual rainfall in the area is about 719 mm, out of which about 80% occurs during southwest monsoon season. The topography of the area is generally flat to gently sloping, with the elevation ranges from 600 m to 730 m above mean sea level.

The Indian Remote Sensing satellite digital data of IRS 1C LISS III (Row 62 and Path 98) along with scanned SOI top sheets nos. 57 A/1, 57 A/2 and 57 A/5 (1:50,000) were used for the preparation of base maps like watershed boundary, drainage, contour map etc. The various thematic maps like land use, soil texture and slope maps were created using the various operations and map calculation utilities of the GIS software namely Integrated Land and Water Information System (ILWIS). The land use/cover map is shown in Fig. 2. Among several possible methods of water balance calculation, the one introduced by Thornthwaite and Mather (1957) is applied for the present study (Durbude *et al.*, 2001). Details of soil and water conservation structures, their applicability and suitability under various soil and slope conditions are presented in the table 1. The decision rules are formulized for selection of sites for various soil and water conservation structures as per the guidelines given by Integrated Mission for Sustainable Development (IMSD, 1995), Indian National Committee on Hydrology (INCOH) and the criteria given as per the field manual (Table 1).

Table 1: Decision Rules for the Selection of Suitable Locations for the Various Soil and Water Conservation Structures

Structures	Area	Slope	Permeability	Run-off Potential
Contour Bunding and Land Leveling		Nearly level to Medium slope	Low	
Farm Pond	> 2 ha.	Nearly Level to Gentle slope	Very Low	Low/Medium
Gully plug		Gentle to steep slope	Low to Medium	
Percolation tank and Nala bund	> 40 ha.	Nearly level to Gentle slope	Medium to high	Low/Medium

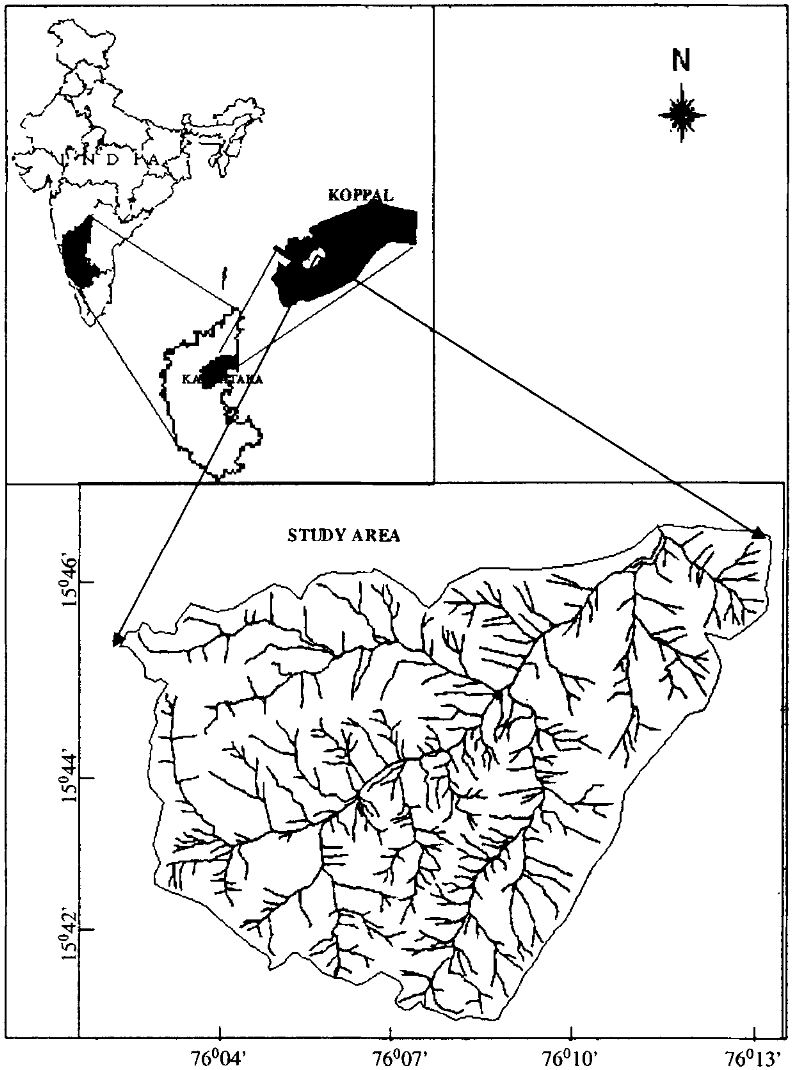

Fig. 1. Location Map of the Study Area

Based on the land use/cover and soil textural analysis, the study area has been divided in to five major categories as described in the table 2. Physiographic soil texture classes were obtained by considering the land use/cover and drainage pattern of the area. The distribution of the various soil textural classes is shown in table 3. The slope (percentage) map was classified in to four major categories as described in the table 4. The different type of land use/cover and soil texture combinations (called as water holding zones) obtained after crossing the land use/cover map and the soil texture map. From the calculations of the water balance for each individual water holding zones, the average annual run-off from the study area was estimated as shown in the table 5. The annual runoff from the study area is found as 193.17 mm, which is 26.87 % of the average annual rainfall. From the annual

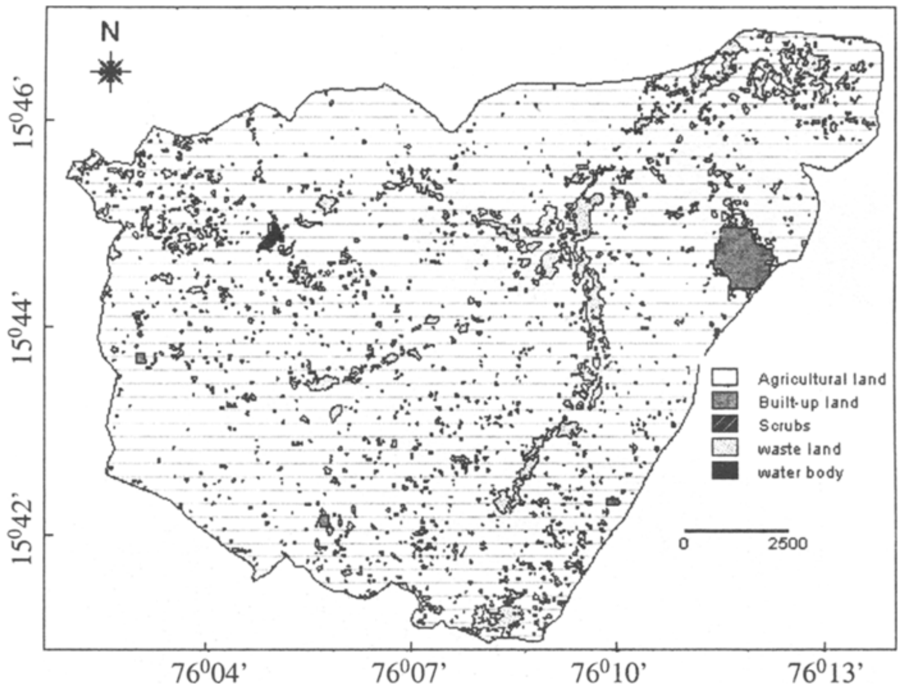

Fig. 2. Land Use/Cover Map

values obtained for each land use-soil texture classes, the runoff potential map was generated, which is classified into no runoff, low runoff, moderate runoff and high runoff potential zones (Fig. 3). Since, high runoff potential is found in built-up land only, which is not suitable for soil and water conservation sites and hence low and moderate runoff potential zones are only considered as suitable locations for soil and water conservation structures.

The various soil and water conservation structures were identified by integrating land use map, soil texture map, classified slope map and the runoff potential map and applying the decision rules. The spatial distribution and the areal extent of various sites for soil and water conservation measures are given in table 6 and shown in the Fig. 4. All the suitable sites for farm ponds, gully

Table 2: Spatial Distribution of Various Land Use Cover Classes Identified in the Study Area

Land Use/Cover	Area (ha.)	Area (%)
Agriculture	16063.60	88.84
Built-up Land	182.84	1.01
Shrubby land	34.88	0.19
Waste Land	1781.76	9.85
Water Body	18.56	0.10

Table 3: Spatial Distribution of Various Soil Texture Classes Identified in the Study Area

Soil Texture	Area (ha)	Area (%)
Clay	2531.36	14.00
Clay Loam	12497.68	69.12
Sandy Clay Loam	3052.60	16.88

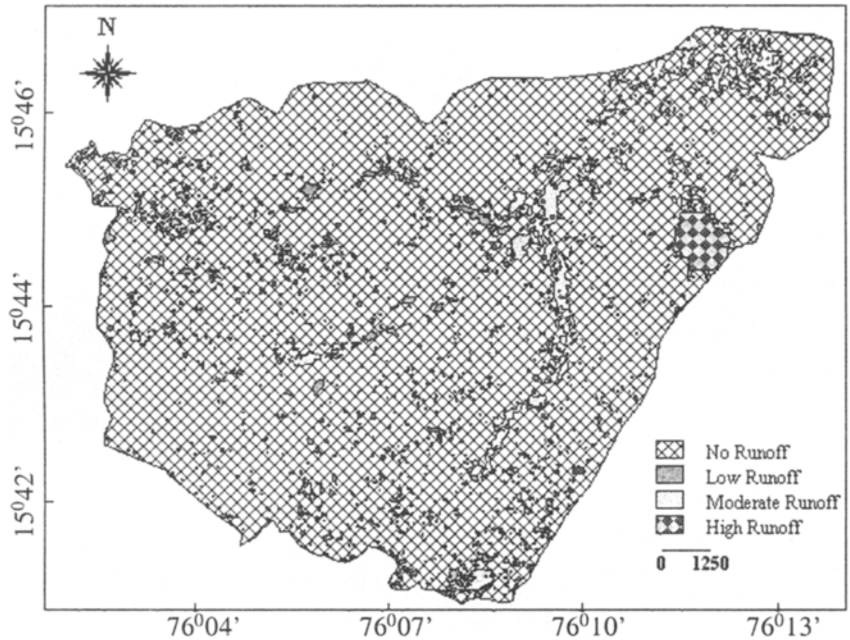

Fig. 3. Runoff Potential map

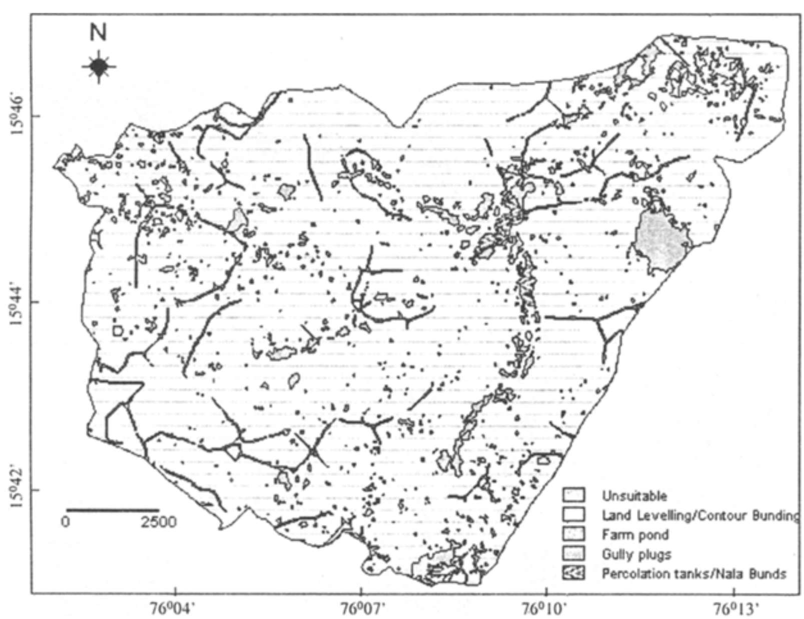

Fig. 4. Site Suitability Map for Soil and Water Conservation Structures

Table 4: Spatial Distribution of Various Slope Classes Identified in the Study Area

Slope Classes	Slope %	Area (ha)	Area (%)
Nearly level	0 - 1	11744.40	64.95
Gentle slope	1 - 5	5900.44	32.63
Steep slopping	5 - 10	148.64	0.82
Very steep slopping	> 10	288.16	1.59

plugs and percolation tank and nala bunds (Measures for drain line treatment) were checked by overlaying the drainage map and they are found close to the drain or on the drainage. Hence water availability for these structures can be confirmed. The buffer map created for built-up land was overlaid on the site suitability map. It can be seen that some portion of the identified locations of soil and water conservation measures fall within the buffer zone, which cannot be considered suitable for the soil and water conservation activities. Hence, all the sites outside the buffer zone can be developed for the suitable structures.

From the water balance study, it is found that, there is no surplus water available for runoff in most of the water holding zones, which indicates the hydrological drought condition in the region. Since, the major land use identified in this watershed is agriculture, and hence the potential area for contour bunding and land leveling is found to be maximum. A very negligible area is identified for farm pond due to flat topography of the watershed. The percolation tanks and gully plug are usually preferred in the public wasteland, which is comparatively very less, hence very less potential area for these structures are identified.

Table 5: Run-off Computed for the Various Water Holding Zones

Land use / cover	Soil Texture	Area m^2	Root Zone Depth (m)	Available Water Capacity of Root Zone (mm)	Runoff (mm)	Run-off (m^3)
Water body	Clay loam	25600	0.0	0.0	0.0	0.0
Water body	Clay loam	800	0.0	0.0	0.0	0.0
Waste land	Sandy clay loam	9533200	0.5	75.0	50.1	477518.0
Waste land	Clay loam	13514800	0.4	100.0	26.1	352601.1
Waste land	Clay	47576000	0.3	75.0	50.1	2383081.8
Built-up land	Sandy clay loam	1706400	0.0	0.0	503.3	858831.1
Built-up land	Clay loam	309600	0.0	0.0	503.3	155821.7
Built-up land	Clay	702400	0.0	0.0	503.3	353517.9
Agricultural land	Sandy clay loam	83624400	1.0	150.0	0.0	0.0
Agricultural land	Clay loam	126431200	0.8	200.0	0.0	0.0
Agricultural land	Clay	291336400	0.5	150.0	0.0	0.0
Shrubby land	Sandy clay loam	631200	1.0	150.0	0.0	0.0
Shrubby land	Clay loam	482000	1.0	250.0	0.0	0.0
Shrubby land	Clay loam	2644000	0.7	200.0	0.0	0.0

Table 6: The potential area for the various soil and water conservation structures

Name of Soil and Water Conservation structures	Potential Area (ha)
Contour bunding and Land leveling	16162
Farm pond	—
Gully plug/nala plug	93.60
Percolation tank and Nala bund	100.72

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