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Prioritization of Sub-Watersheds of Sweta Nadi Basin, Using Weighted Overlay Analysis Through The Gis For Sustainable Development And Management

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ABSTRACT

Watershed prioritization is the scientific way of watershed marking out and monitoring. The Sweta Nadi basin is located in Semi arid tract of Tamil Nadu. For the prioritization of watershed integrated techniques involving GIS has been found to be effective for watershed development, this process based on parameters are morphometric characteristics, geomorphology, slope, soil, landuse/landcover, rainfall, lcc, lic, soil texture, soil erosion, soil drainage, drainability, density, texture and length of overland flow. On the basis of priority and weightage assigned to each thematic map, the sub-watersheds have been grouped in three categories such as high moderate and low. The prioritization results reveal that seven sub-watersheds rank highest on the basis of weightage and are measured as high priority. These sub-watersheds may be taken up with development and management plans to conserve natural resources on sustainable basis with immediate effect, which will ultimately lead to soil and water conservation.

KEY WORDS: Prioritization, GIS, Sub-Watersheds, Weighted overlay and Sustainable Development

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INTRODUCTION

Management of natural resources on sustainable core is of most significance in today's situation. Sustainable increase in production of food grains, fiber, fodder, etc. is a most to meet the need of rising population. The planners face a problem of arresting a balance between two challenging demands of development and management conservation of natural resources. Present study could be achieved if the thematic maps on geomorphology, land use/ land cover, soil and slope etc. are seen in an integrated fashion used overlay analysis. Biswas[1] in 1999 studies on the prioritization of sub-watershed based on morphometric analysis of drainage basin using GIS techniques. Lambin[2] in 2001 carried out a land use/land cover is an important component in understanding the dealings of the human behavior with the environment and thus it is required to be able to simulate changes. Giri[3] in 2003 studied the causes of LULC changes most important deforestation and land degradation include quick economic development, population growth and poverty. Arun[4] in 2005 attempted a physiographic characterization of drought prone watershed used remote sensing and GIS techniques in Gandeswari watershed in Bankura district of west Bengal. Nooka Ratnam[5] in 2005 evaluated check dam positioning by prioritization of micro-watersheds using method of silt yield index (SYI) model and remote sensing and GIS in Midnapur district of West Bengal. Solanke[6] in 2005 studied on the watersheds characterization and management of Ganeshapur watershed of Nagpur district. Trung[7] in 2006 made a study GIS, which has strong capacity in data integration, analysis and visualization has become an important tool to support land use planning approaches. Srinivasa Vittala[8] in 2008 studied on the prioritization of sub-watersheds for sustainable development and management of natural resources, An integrated approach using remote sensing, GIS and socio-economic data in North Pennar basin. Sandeep kumar yadav[9] in 2016 made a recent study on prioritization of sub-watersheds based on the earth observation data of agricultural dominated in upper tons river basin. Surendra Kumar Chandnih[10] in 2017 studied on the prioritization of sub-watersheds based on morphometric analysis using geospatial technique in Piperiya watershed.

STUDY AREA

The Sweta River basin lies in the districts of Namakkal, Salem, Tiruchirappalli and Perambalur of Tamil Nadu State. The Sweta River originates from the northern parts of Kolli hills in Namakkal District. It is located between 11^0 15' N and 11^0 45' N latitudes and 78^0 15' E and 78^0 58' E longitudes (as read from the survey of Indian Topographic sheets C44A6 (58 I/6), C44A7 (58 I/7), C44A10(58 I/10), C44A11(58 I/11) and C44A15(58 I/15) (Fig.1). The river originates from the northern parts of Kolli hills, a part of Manmalai, adjoining Kolli hills and Palakkadu Malai in

Pachamalai. The total geographical area of the basin is 1,034.43 Sq. km (1,03,443 ha) within 82 Revenue villages. The study area is based upon the three major relief orders such as the hills, uplands, and the plains. The river runs over 116 kms from the west to the east, and joins Vellar River, which runs into the Bay of Bengal (Fig.1).

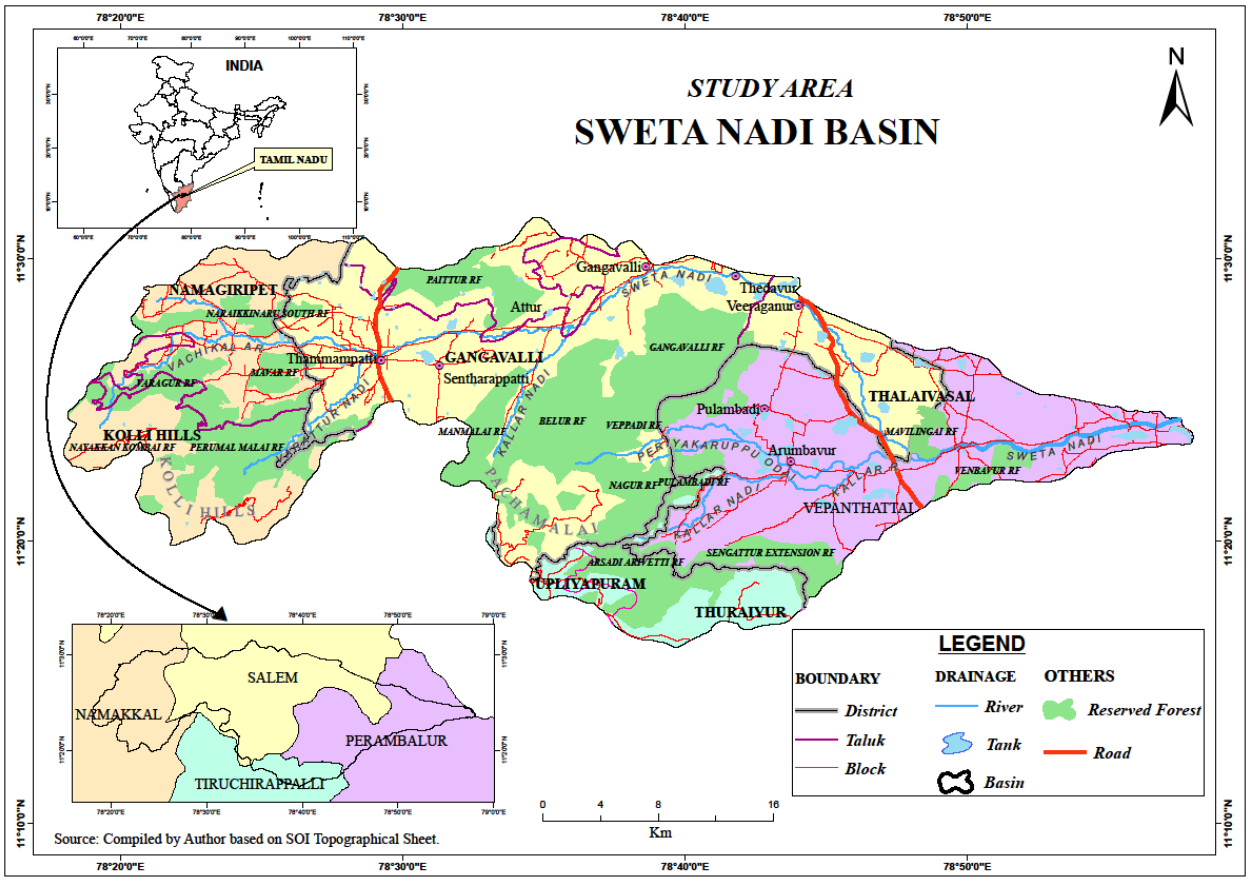


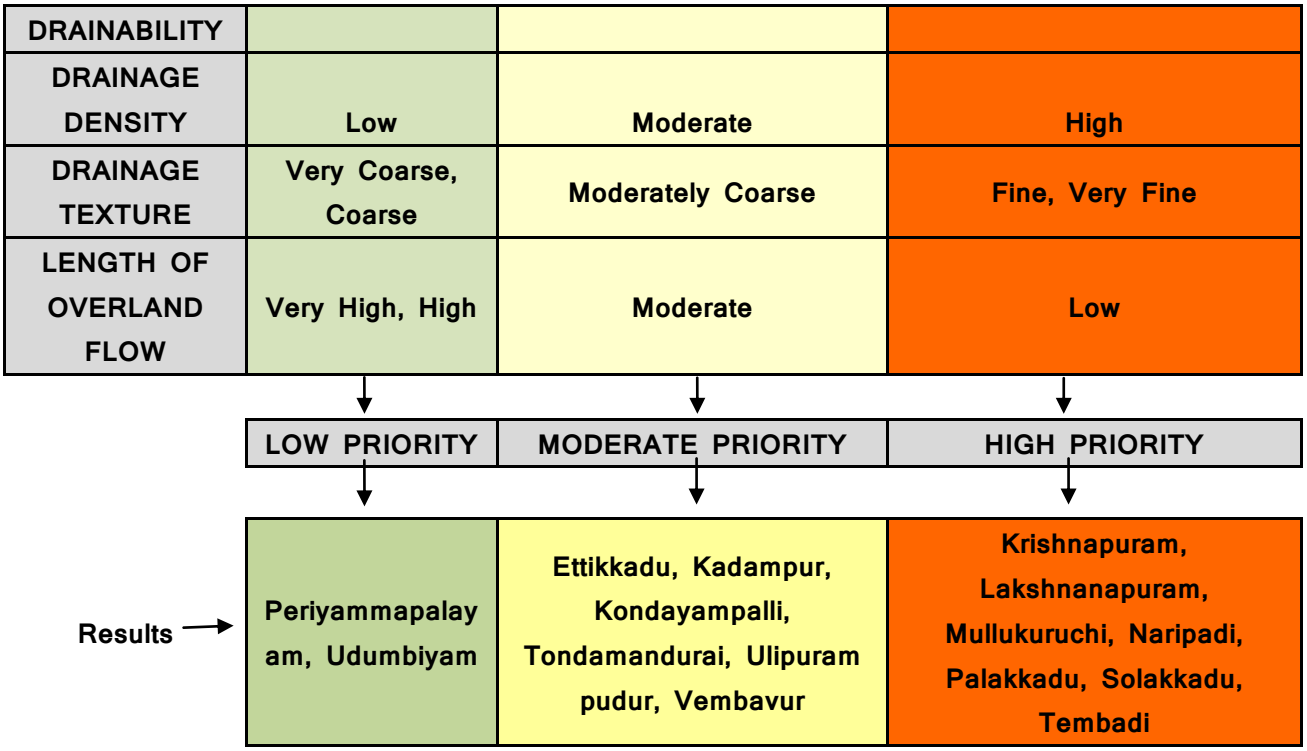
Fig- Fig. 1. Study Area-Sweta Nadi Basin

MATERIALS AND METHODS

The sub – watershed boundaries were demarcated on the basis of contour value, slope, relief, elevation, slope and outlet point. Digitization work has been carried out for entire analyses of basin

Table 1. Prioritization of sub-watersheds using rank system based on weightage

	PRIORITIZATION OF SUB WATERSHEDS		
PARAMETERS	RANK 1	RANK 2	RANK 3
GEOMORPHOLOGY	Pediment - Valley Floor, Shallow Flood Plain, Piedmont Slope, Valley Fill	Moderately weathered Pediplain, Shallow Buried Pediment, Shallow weathered Pediplain	Dome type Denudational Hills (Large), Dome type Residual Hills, Hilltop Weatered, Inselberg, Linear Ridge, Structural Hills
SLOPE	Nearly Level, Very Gently Sloping	Gently Sloping	Moderately Sloping, Moderately Steep to Steep, Steep sloping, Strongly sloping, Very Steep
SOIL	Palladam, Periyanaickenpalaiyam, Periyamalai, Ilaiyamuttur, Kommalapatti, Kottayam, Ammapettai, Madattupatti, Alagapuri	Velimadurai, Kadiripuram, Ammapalayam, Maramangalam, Kombaikkadu, Settuppalapatti, Thoppur, Salem, Virapandi, Kadiyampatti, Kanakanur, Kuruvakkadu, Kollihills, Tulukkanur, Chattirapatti, Vanavasi	Upparapatti, Kunnattur, Vadamalapuram, Bhavanisagar, Tolurpatti, Ooty, Kirakad, Kombuthuki, Nagalur, Chittodu, Chinnamettur
LANDUSE /LANDCOVER	Crop Land, Waterbody	Agriculture Plantation, Fallow/Agriculture, Waste land with Scrub	Decidous Forest, EvergreenForest, Urban,Rural, Gullied/Ravinous Land, Sandy Area, Scrub Forest, Barren Rocky
RAINFALL	>900 mm	700 -900 mm	<700 mm
LCC	III s, III w, III e	IV s, IV es, IV ws	VI es, V s, VII e
LIC	2s, 2sd	3st	4st, 5t, 6
SOIL TEXTURE	Clay, Clayloam	Loam, Loamysand, Sandyclayloam, Sandyloam, Siltyclay	Sandyclay
SOIL EROSION	None to Slight Erosion	Moderate Erosion	Severe Erosion
SOIL	MWD, WD	ID, P	ED, SED



morphometry and weighted overlay analyses using GIS Software (Arc GIS 10.1). Quantitative morphometric analysis was carried out in all the 15 sub watersheds and morphometric parameters such as drainage density, drainage texture and length of overland flow were computed using standard methods and formulae (Horton[11],1945). Land use and land cover map of 2012 by using geographical information technology. These studies were employed by using the remote sensing data of Resourcesat-2 LISSIII and area was classified up to level II classes and delineation of 16 land use/land cover categories based on NRSA technical guidelines. ASTER data collected from Global Land Cover Facility (GLCF) have been utilized for extracting relief (up to five level) and slope (up to eight level) of the study area. Geomorphology (13 types of landform features) has been brought out from Combination of Survey of India Toposheets and Landsat ETM False Color Composite Image. Soil details (LCC, LIC, Soil Texture, Soil erosion, Soil Drainability) have been collected from Tamil Nadu Agricultural University (TNAU), Coimbatore. Rainfall (30 years) data have been brought from Directorate of Economics and Statistics, Chennai and finally all data values are ranked and compiled by author then using weighted overlay analysis through the Arc GIS Software after that displayed results are Table and maps (Table.1, Fig.2,3 and 4).

RESULTS AND DISCUSSION

Prioritization of Sub Watersheds

The preparation of the basin Prioritization map for sustainable development involves the integration of such layers (parameters) as geomorphology, slope, soil, landuse/ landcover, rainfall, LCC, LIC, soil texture, soil erosion, soil drainage, drainage density, drainage texture and Length of overland Flow. The bulk database including 1118 land resource units with their land and drainage characteristics are ranked (table.1). The present study into categorizing the Sweta nadi basin for agricultural development. The basin divided into three categories, namely high, moderate and low priority for agriculture development (Fig.4). The study is carried with considerations of the relevant parameters are used above said parameters for the analysis of resource land units, according to the strength and weakness of each resource unit based on land evaluation techniques. The ranks of the each parameter were calculated and analysed in GIS bring out the priority of entire sweta nadi basin. Ranked of themes are determined by the close contribution to the site selection of high priority, moderate priority and low priority areas. Further, each sub watershed based on the percentage of area covered by each priority within each sub watershed (table.2). The priority of sub watershed represented in the suggested will be helpful to the planners, administrators and decision makers, while implementing any land use development plan for this basin.

High Priority

High priority of seven sub watersheds are Krishnapuram, Lakshnanapuram, Mullukuruchi, Naripadi, Palakkadu, Solakkadu and Tembadi. It is covering areas of sub watersheds 51 % of the total study area. These are the lands extreme limitations for agricultural production.

This category of sub watershed lands has extreme limitations for agricultural production. These limitations consisted following combination. Mainly associated with moderate slope to steep slope, rugged topography, coarse grained soil, high drainage density and low infiltration capacity. Land use types come under mostly forest, wastelands and most areas having dry forming agricultural activities are found in this priority. The land is unsuitable cultivation because erosion activities are very high. High priority of sub watersheds is having one of the major biodiversity zone in the study area. Hence, the government should come forward to take effective measures to protect the land under forest and agriculture in the zone, proper land use planning is needed, otherwise we loss our natural resources, Proper guidance and training should be provided to the local people who knowingly or unknowingly deplete the forest resources and land resources.

Moderate Priority

Sub watersheds under Moderate priority (6): Ettikkadu, Kadampur, Kondayampalli, Tondamandurai, Ulipuram pudur and Vembavur covered by 36 % of the total area of the basin.

Moderate priority land is suitable grazing but soil constrains reduce the overall level production and may be limit cropping to a rotation with sown pastures. The area under well irrigation and dry land under moderate priority are cultivated commercial crops, fruit crops are mango, banana and sapota, oil seeds crops and plantation crops like coconut, Arecanut and cashew. Moderate erosion with lands have severe soil limitations. Suggested land use for agricultural crops in these areas. Moderately good cultivable land under this category of priority of watersheds.

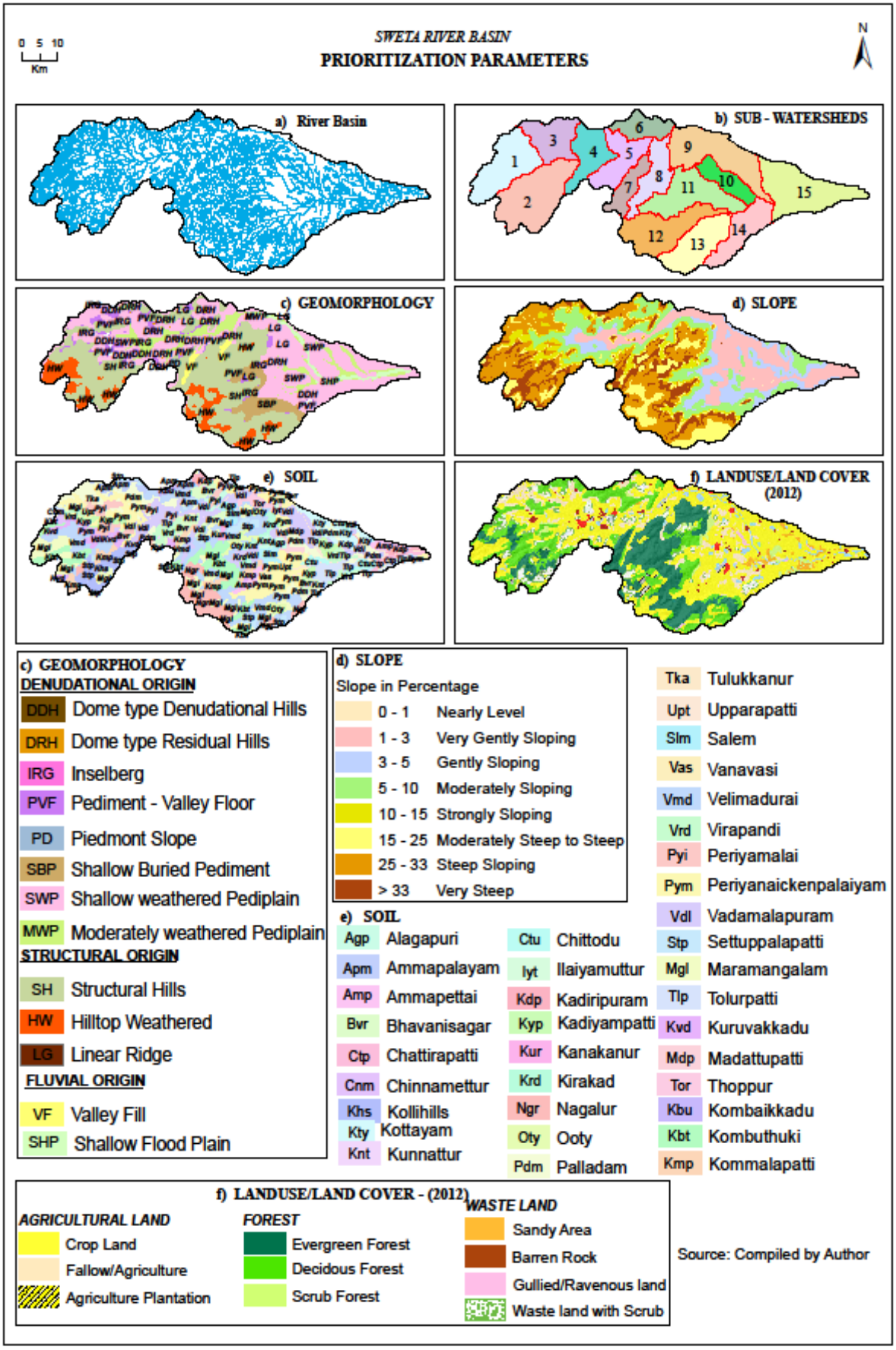


Fig. 2. Prioritization parameters (a,b,c,d,e,f)

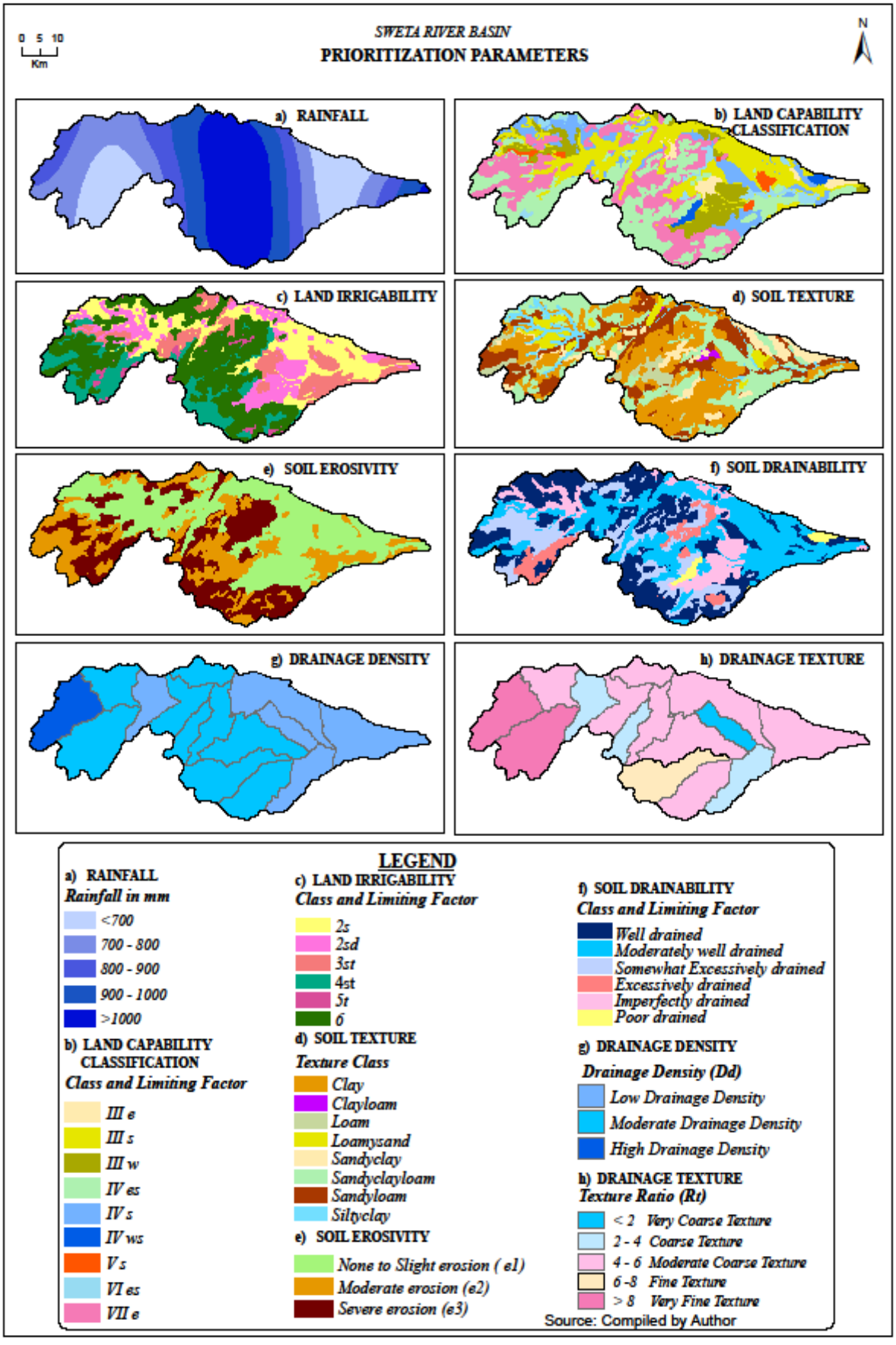


Fig. 3. Prioritization parameters (a,b,c,d,e,f, g,h)

Table 2. Prioritization of sub watersheds for Sweta Nadhi Basin

Sl. No.	Name of the Sub watersheds	Priority within each sub watersheds (Area in %)			Overall Priority
		Low	Medium	High	
1	Ettikkadu	0.5	60.1	38.9	Medium
2	Kadampur	2.6	60.7	36.6	Medium
3	Kondayampalli	23.9	55.8	20.3	Medium
4	Krishnapuram	15	31.4	53.5	High
5	Lakshnanapuram	7.1	34.5	58.5	High
6	Mullukuruchi	0	33.3	66.6	High
7	Naripadi	2	25.6	72.3	High
8	Palakkadu	28.1	25.2	46.7	High
9	Periyammapalayam	73.2	7.1	19.6	Low
10	Solakkadu	0.3	21.2	78.5	High
11	Tembadi	24.7	17.6	57.8	High
12	Tondamandurai	24.5	51.4	24.1	Medium
13	Udumbiyam	66	20	14	Low
14	Ulipuram pudur	1.2	74.2	24.6	Medium
15	Vembavur	34.7	64.5	0.7	Medium

Source: Compiled by Author

Low Priority

Sub watersheds under Low priority (2): Periyammapalayam and Udumbiyam 13 % of the total area of the basin. These are the sub-watersheds have sustaining regular cultivation, soil profile is well drained to moderately well drained, erosion hazards are low, soil conservation management practices are required to protect the soils from erosion. Apart from the above suggestions, the recommendations for each sub watershed has been given in the following points to have better land and water management to attain sustainable development of the basin.

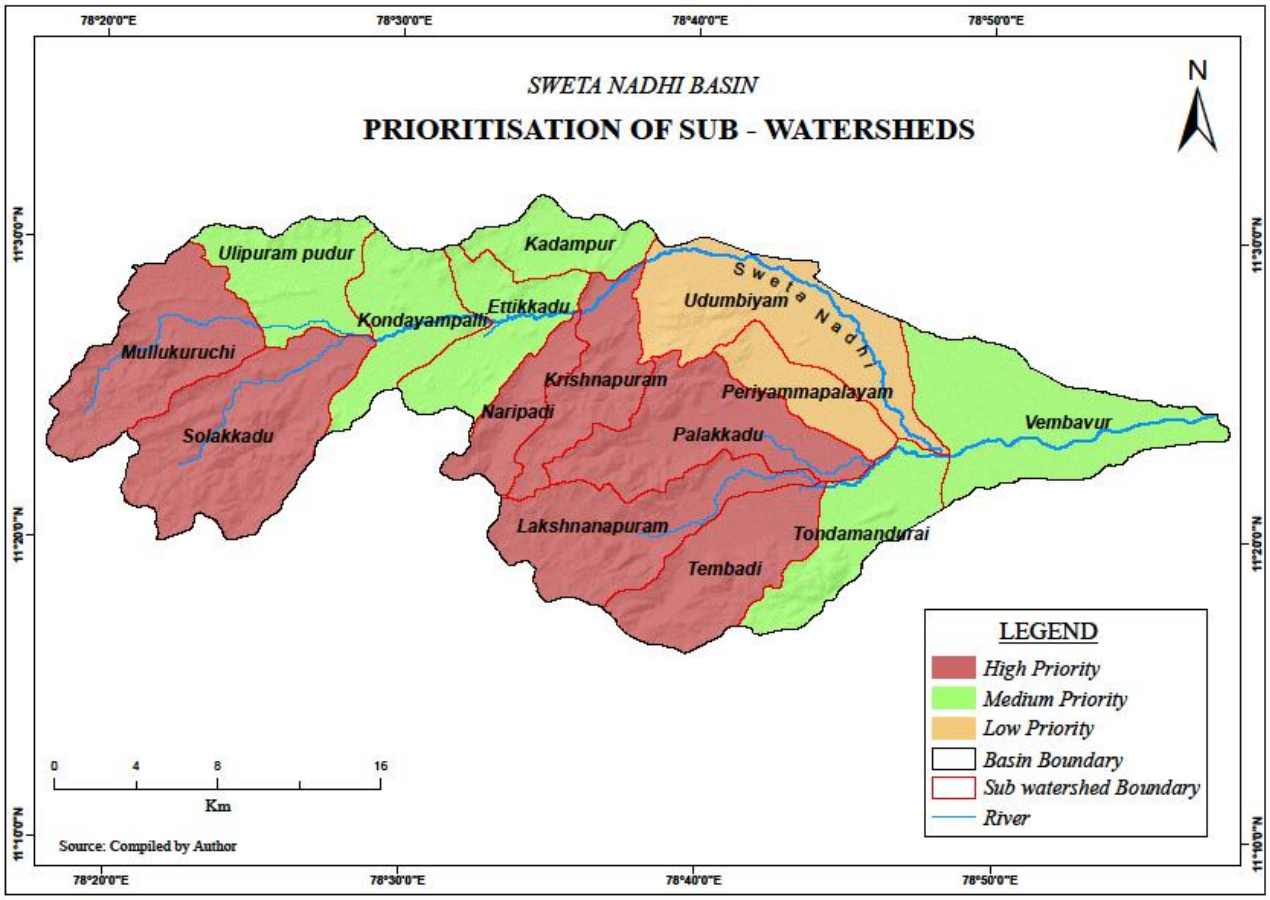


Fig. 4. Prioritization of sub-watersheds

CONCLUSION

Watershed prioritization is one of the most important aspects of planning for accomplishment of its development and management programmes and decision making process for water resources management. The present study demonstrates the helpfulness of GIS for weighted overlay analysis and prioritization of the sub-watersheds of Sweta Nadi Basin, India. Results of prioritization of sub-watersheds show that high priority sub-watersheds are more at risk to soil erosion. Therefore, immediate attention towards soil conservation measures is required in Krishnapuram, Lakshnanapuram, Mullukuruchi, Naripadi, Palakkadu, Solakkadu and Tembadi sub-watersheds to preserve the land from further erosion and to improve natural hazards. A total of 1118 land units has been identified and delineated so that land uses and characteristics could be analyzed at the micro level, facilitating farm development planning for sustainable development. To restore and maintain the ecological balance in the upland area, concentrated efforts are being made to undertake degraded forest areas by taking up afforestation actions and arrest the destructive effects of soil erosion. Degraded areas are tackled by taking up suitable afforestation and soil and moisture conservation measures. Afforestation in the scrub land and reforestation in the deciduous forest are in extreme

need to avoid depleting forest resources. Forest plantation should have tree planting and terrace cultivation in order to reduce soil erosion and high water run-off. Ravenous land in the eastern part of the study areas under unproductive use can be successfully reclaimed by planting Bamboo, a fast growing plant species and fodder crops, due to less runoff, soil loss and control soil erosion.

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