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Surface Runoff Estimation Using SCS-CN Method for Kurumballi Sub-watershed in Shivamogga District, Karnataka, India

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ABSTRACT

SCS-curve number (CN) is one of the most well-liked and commonly applied methods for estimating surface runoff. The present study aims to calculate surface runoff using SCS-CN watershed-based calculation and geospatial technology in the Kurumballi sub-watershed Shivamogga District of Karnataka, India. The study area covers about an area of 47.67 sq. km. The union of land use/land cover classification with hydrological soil groups (HSG) yields the runoff estimation by the SCS-CN curve approach. This method calculates the runoff volume from the land surface flows into the river or streams. Moreover, the study area's delineation of runoff potential zones was done using the thematic integration method. Different thematic layers were used, including lithology, geomorphology, soil, slope, land use and land cover, drainage, surface water bodies, groundwater contour, and isohyetal maps.
Furthermore, associating it with the SCS-CN technique, the total surface runoff volume of the study area was estimated. The total surface runoff volume in the study area is 21065849.7 m^3. To this study, thematic integration with the SCS-CN approach to estimate runoff for watersheds is valuable for improving water management and soil conservation.

INTRODUCTION

The process of hydrological modeling is vital for water resource management. One of the significant challenges in this field is the analysis of surface runoff based on rainfall. This analysis is crucial for developing, planning, and managing water resources. Observing water quantity through hydrological models is a challenging and scientific task, especially in semi-arid regions (Gajbhiye et al. 2015, Perez-Sanchez et al. 2019, Karunanidhi et al. 2020). Water movement over the land surface and into a defined channel is classified as overland flow. If water infiltrates and moves horizontally close to the soil surface before ultimately reaching a channel, it is known as interflow (Fitts 2002). When groundwater contributes to the overall flow of a stream, it is referred to as base flow, while the collective flow of the stream is known as runoff (Fetter 2001). Typically, water flow is measured in terms of surface runoff, a momentary flow that combines with other waterways to create a watershed (Rao et al. 2010). When determining the volume of surface runoff in an ungauged basin during a rainfall event, the SCS curve number model is a commonly used method. This model employs runoff curve numbers developed by the USDA Soil Conservation Service (SCS 1985), considering various factors such as soil type, land use/treatment, surface condition, and antecedent moisture conditions.

The SCS-CN model is a well-established and recognizable approach known for its stability and ability to incorporate various factors contributing to runoff, including both spatial and non-spatial data sets, such as monthly precipitation, land use/land cover, soil, slope, hydrology, and antecedent moisture conditions (AMC) are used with multi-temporal datasets (Shi et al. 2009, Tejram et al. 2012, Viji et al. 2015, Matej et al. 2016, Shah et al. 2017, Al-Juaidi et al. 2018, Arya et al. 2020). Moreover, the above-mentioned parameters, along with the drainage density, topography, watershed size, and shape, the quantity of direct surface runoff is determined (Agarwal et al. 2014; Tailor & Shrimali, 2016). An essential advantage of this method is its seamless integration with geographic information system (GIS) techniques, as the model's required parameters are predominantly geographical. Researchers have made numerous efforts to approximate surface runoff using the SCS-CN method. This approach involves integrating remote sensing data to evaluate the hydrological characteristics of a given watershed. The SCS-CN model is implemented by utilizing high-resolution satellite datasets, which allow for the mapping of impervious surfaces (Mondal et al. 2009, Ansari et al. 2016). Additionally, the SCS-CN model is utilized in conjunction with the Universal Soil Loss Equation (USLE) to determine the sediment yield of a given watershed during rainstorms (Mishra et al. 2006). The SCS-CN model was utilized for this study, classified as an empirical model. It is the most widely recognized and trusted method among hydrologists (Williams & LaSeur 1976, Bondelid et al. 1982, Voda et al. 2019, Verma et al. 2020). The model relies on four catchment features: hydrologic soil group, land use, surface condition, and antecedent moisture condition (AMC) (Bansode & Patil 2014).

The SCS-CN method is frequently utilized to assess the seasonal variation of rainfall-surface runoff, which is instrumental in developing resource management protocols involving vegetative and engineering measures (Muthu & Santhi 2015, Anubha et al. 2015) employing GIS techniques to determine a watershed's annual surface runoff depth. Meanwhile, Joy, 2016 utilized the NRCS-CN method to evaluate the surface and average runoff depth. GIS is a commonly utilized tool amongst researchers in conjunction with the curve number approach, as it has demonstrated efficacy in estimating runoff quantities in an efficient and precise manner (Devia et al. 2015). The curve numbers are assigned based on soil type and its infiltration capacity for water across different land use categories. Soil is classified into four hydrological classes: A, B, C, and D. The curve numbers differ depending on land use, soil type, and hydrological variables (Amutha & Porchelvan 2009). Antecedent moisture conditions predict the direct runoff volume for a specified rainfall event by applying the SCS-CN runoff model (Satheeshkumar et al. 2017). We use a curve number to measure the amount of rainfall that becomes surface runoff versus the amount absorbed into the soil (McCuen 1982). A high curve number indicates heavy runoff and low infiltration usually in urban environments. In contrast, a low curve number indicates low runoff and high infiltration most common in dry land (Sayl et al. 2019).

The CN factor values were obtained from different soil, land use, and land management circumstances. However, if available, evaluating the CN value using recorded rainfall-runoff data is better (Liu & Li 2008, He 2003). Previous studies have shown that CN values derived from recorded data vary consistently with the depth of the rainfall, so it is recommended to determine a single CN value (Mishra et al. 2013). In identifying optimal locations for water collection or underground water recharge, Geographic Information Systems (GIS) and Remote Sensing (RS) are indispensable tools. These modern and efficient technologies have surpassed traditional approaches (Khaddor et al. 2017). They are crucial in gathering data on various land use and soil types, which are used to determine curve numbers that play a significant role in runoff estimation (Bo et al. 2011). Consequently, hydrological studies can be conducted with precision through GIS and RS technology, making them increasingly popular for natural resource management, planning, and development purposes. GIS is also valuable in decision-making by integrating multiple data sets and performing spatial analysis (Jasrotia et al. 2002).

Therefore, this study focuses on utilizing the SCS-CN model in the Kurumballi subwatershed to model runoff via Remote Sensing and Geographic Information System with aiming to achieve the following objectives 1. To prepare and map the thematic layers that influence the surface runoff, 2. To estimate the surface run-off using a combined SCS-CN method and thematic integration, and 3. To determine the volume of run-off using rainfall intensity and depth.

STUDY AREA

Kurumballi sub-watershed is located in the Shivamogga district and covers an average area of 47.67 sq. km. The mini-watershed can be found between latitude 13°59' 24.95" N and longitude 75°21'36.35" E, covered in a survey of India toposheets of 48 N/8 and 48 O/5. Throughout the year study region experiences a temperate environment. June through October sees the majority of the southwest monsoon's rainfall. The Kurumballi Sub-watershed averages 99.804 millimeters of annual precipitation and 21.8°C on average for minimum and 31.8°C on average for maximum temperatures. The location map of the study area is shown in Fig. 1.

GEOLOGICAL SETTING

The study area is well known that the Gneissic complex surrounding the main schist belt is replete with remnants of high-grade metamorphic rocks which are concordant to the fabric of the enclosing gneissic complex lithologically, which represents Archean Migmatites& Granodiorite-Tonalitic Gneiss, Quartz Chlorite Schist with OrthoQuartzite and older Granites.

MATERIALS AND METHODS

The Survey of India toposheets 48 N/8 & 48O/5 on a scale of 1:50,000 were used to create the base map and delineate the Kurumballi subwatershed. In addition, this study gathered secondary datasets and remote sensing data from several governmental organizations. The current study involved the production of rainfall maps using rainfall data from the Department of Statistics in Bangalore. Monthly rainfall data spanning 2011 to 2022 were acquired. The generation of isohyets was accomplished by utilizing ArcGIS. Using ArcGIS software (v. 10.4), all data items were digitally transformed and georeferenced with the UTM and WGS-84 projection/coordinate system (Karunanidhi et al. 2020).

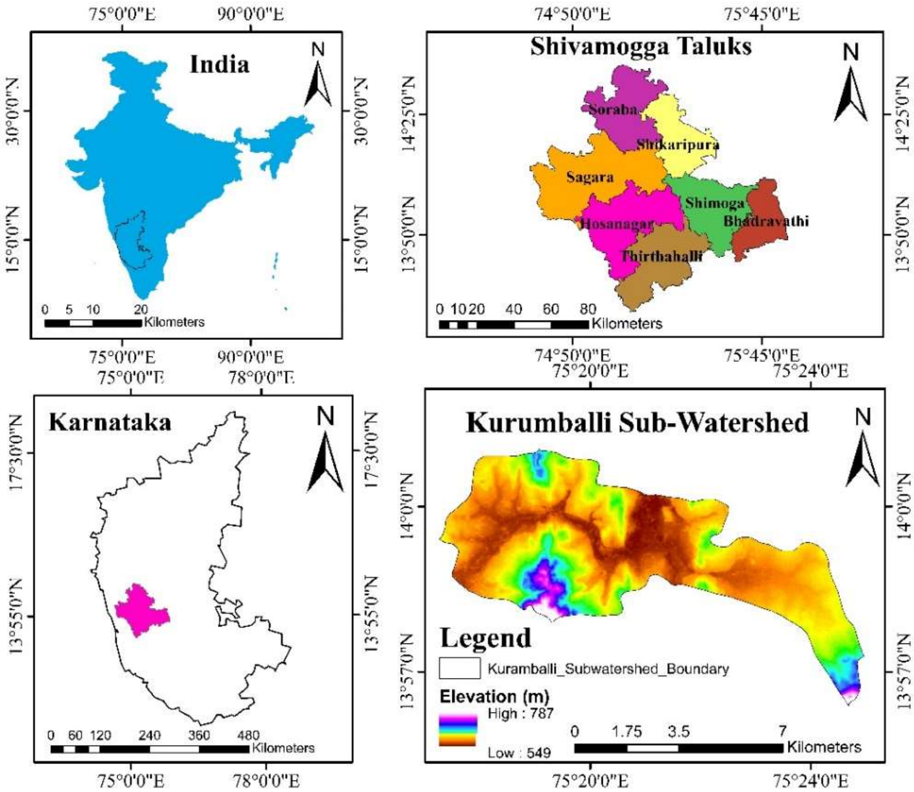

Fig. 1: Location Map of the Study Area.

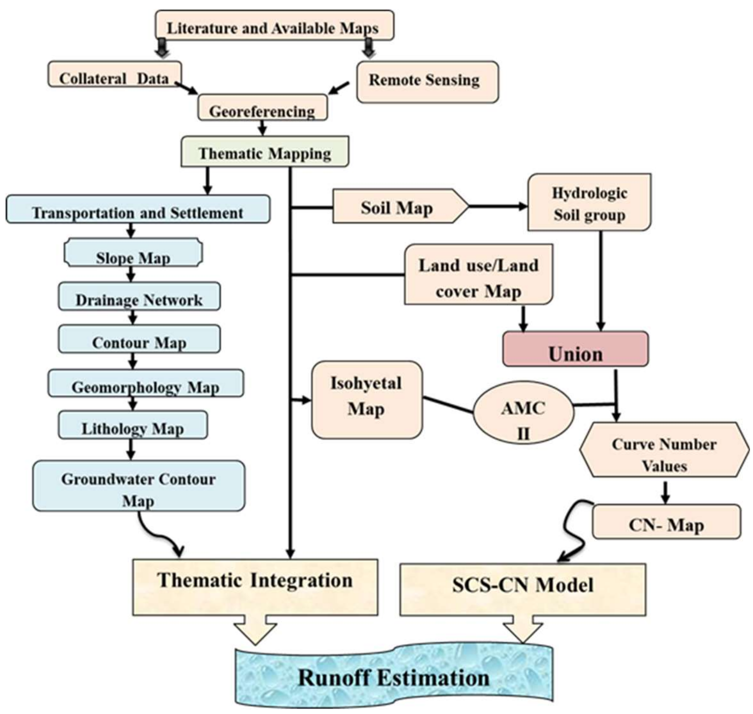

Fig. 2: Flow chart showing the methodology adopted for this investigation.

The soil map of the study area was collected from NBSS/LUP Bangalore. The resulting soil texture map was then used to delineate hydrological soil groups (HSG). Satellite imagery Sentinel II-A 2022 was used to create a land use/land cover (LULC) map, which was then spatially intersected to assign a Curve Number (CN) to each respective polygon in a GIS environment. Finally, all polygons were assigned CN values, further area-weighted method was used to calculate the CN value for each polygon. Following the SCS-CN method (SCS 1985), the runoff potential was estimated using various combinations of HSG, land use, and antecedent moisture condition (AMC) classes (Al-Ghobari et al. 2020, NageswaraRao 2020), the conceptual flowchart of the methodology has depicted in Fig. 2.

SCS Curve Number Method

The soil conservation service curve number (SCS-CN) method was developed by the United States Department of Agriculture's (USDA) soil conservation service (now known as the Natural Resource Conservation Service) in 1954 and is described in section 4 of the National Engineering Handbook (NEH-4) published in 1956. The SCS-CN approach is based on two fundamental principles and the water balance equation. The first hypothesis contrasts the ratio of actual direct surface runoff (Q) to total precipitation (P) (or maximum potential surface runoff) (S) with the ratio of prospective maximum retention (P) to actual maximum infiltration (F) because the second hypothesis connects potential maximum retention (PMR) and initial abstraction (I_a).

The infiltration losses are combined with external storage by the relationship shown below. (Karunanidhi et al. 2020)

$$Q = \frac{(P-Ia)^2}{(P-Ia+S)} \quad \ldots(1)$$

Therefore, 'Q' is the direct surface runoff depth (mm), 'P' is the rainfall depth (mm), and 'Ia' is the initial abstraction before surface runoff begins (mm), which includes the surface storage, interception, and infiltration concerning overflow of the watershed. Finally, 'S' is the potential maximum retention after the surface runoff begins (mm). For the Indian condition, 'S' is the potential maximum retention, which is denoted by (Karunanidhi1 et al. 2020, NageswaraRao, 2020)

The US Soil Conservation Service has found equation 2 by experience, i.e.,

$$I_a = 0.2S \quad \ldots(2)$$

Substituting equation (2) for equation (1), the surface runoff equation is depicted below.

$$Q = \frac{(P-0.2S)^2}{(P+0.8S)} \quad \ldots(3)$$

For P>Ia (0.2S)

S = the potential infiltration after runoff begins, as calculated by the equation below. (Jaysukh et al. 2015)

$$S = \frac{25400}{CN} - 254 \quad \ldots(4)$$

According to Eq. (4), CN (Curve number) is a dimensionless parameter with a range of 1 (minimum runoff) to 100 (Maximum runoff) (Rawat & Singh 2017, Karunanidhi et al. 2020).

Antecedent Moisture Condition (AMC)

Antecedent moisture conditions (AMC) can significantly affect runoff volume as a measure of a watershed's wetness and the soil's capacity to store moisture before a storm (Rawat et al. 2017). Three levels of AMC are essential for the SCS-CN model's execution, and they are listed in Table 1. The total amount of rainfall over the previous five days determines the AMC classification's limitations, which are divided into two categories: the first (growing season) and the second (winter season, dormant season). AMC II is the average moisture condition used in this study (Cronshey 1986). Runoff Curve Numbers (CN) for various LULC categories are obtained for average moisture condition (AMC II) and dry condition (AMC I) or wet condition (AMC II, AMC III) (Table 2). Equation. (5) And (6) are used to calculate the Curve Number for AMC I and AMC III as follows.

$$\text{CN (I)} = \frac{CN(II)}{2.281-0.0128CN(II)} \quad \ldots(5)$$

$$\text{CN (III)} = \frac{CN(II)}{0.427+0.00573CN(II)} \quad \ldots(6)$$

In the preceding equations, CN (II) is the average condition curve number, CN (I) is the dry condition curve number, and CN (III) is the wet condition curve number (Karunanidhi et al. 2020; Tailor et al. 2016)

Area Weighted Curve Number Method

The spatial input maps of soil and land use/land cover are superimposed. These intersection maps represent new polygons called the soil-land map. The value of the curve

Table 1: Classification of antecedent soil moisture condition (AMC).

AMC Group	Soil characteristics	Five-day antecedent rainfall in mm	
		Dormant season	Growing season
I	Dry condition	<13	<36
II	Average condition	13-28	36-53
III	Heavy rainfall/Wet condition	>28	>53

Table 2: Runoff Curve Numbers (AMC II) for Land Use/Land Cover classification are calculated based on the hydrologic soil type. (Source TR55, 1986).

S. No.	Land use Land cover patterns.	Hydrologic Soil Group			
		A	B	C	D
1.	Forest Plantation	25	55	70	77
2.	Plantation	45	53	67	72
3.	Degraded Forest	45	66	77	83
4.	Scrub Forest	33	47	64	67
5.	Encroachment	72	81	88	91
6.	Kharif	64	75	82	85
7.	Settlement	57	72	81	86
8.	Waterbody	97	97	97	97

number varies according to the land use and land cover classes. The obtained results were used to compute the total weighted curve number for the AMC II condition for each polygon of the land area:

$$\text{CNw} = \frac{\sum_{i=1}^{n}(\text{CNi}*Ai)}{\sum_{i=1}^{n} Ai} \quad \ldots(7)$$

In the preceding Eq. (7), 'CNw' denotes the weighted curve number; 'CNi' denotes the curve number for a specific land area; 'Ai' denotes the area of 'CNi, 'and A is the total area of the watershed. (Karunanidhi1 et al. 2020, Tailor et al. 2016, Rawat et al. 2017).

RESULTS AND DISCUSSION

Land Use/Land Cover Pattern

Land use and land cover (LULC) are frequently used to manage the environment sustainably (Karunanidhi et al. 2020). The LULC map was prepared using sentinel satellite data in a GIS environment. The LULC features were identified in the current study using supervised image classification and skilled visual interpretation methodologies. Hence, Scrub forests, Forests, degraded forests, settlements, plantations, forest plantations, and water bodies are the main LULC types identified in the study area (Fig. 3). Most residents in this area work in agriculture, and more than 75% have marginal or very tiny holdings of less than 2 ha. Paddy is the main crop; however, it is also common to see rain-fed crops like maize, Finger Millet, and Ginger in a few isolated locations. Overall, the most critical factors influencing agricultural activity are rainfall and water availability from springs and streams. Arecanut, coconut, cashew, and other plantations are primarily found in mountainous terrain, slopes, and valley floor areas. A total of 27.36% of the area comprises Kharif land, 6.40% of the area comprises forest encroachment, 2.56% of the area comprises Settlement and Forest land includes Plantation (5.46%), Forest Plantation (22.54%) degraded forest (29.46%), and scrubs (4.03%). Forest alteration has been severe due to overgrazing

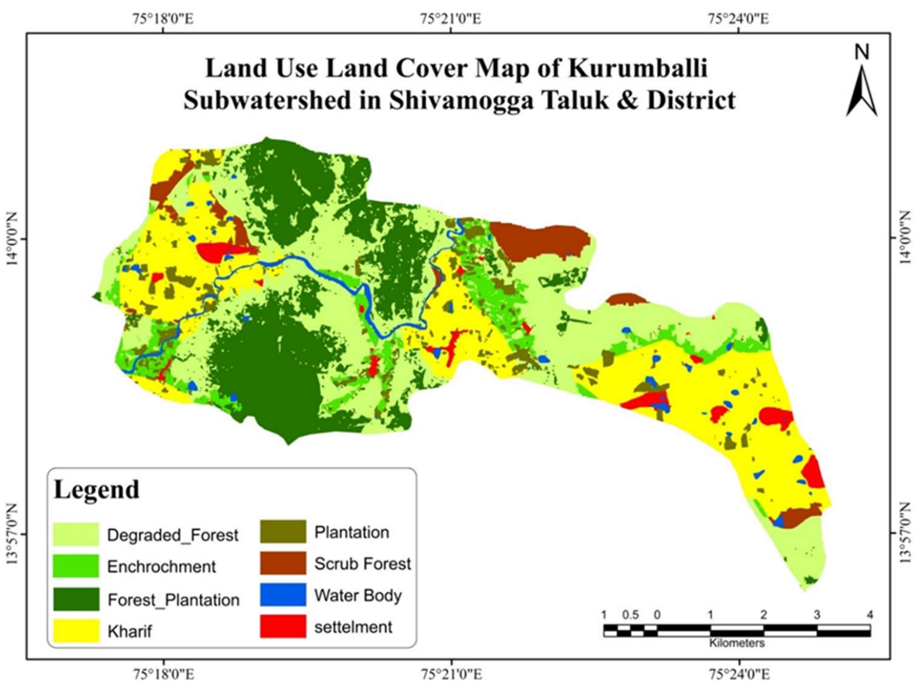

Fig. 3: Land use Land cover map of the study area.

Table 3: Hydrologic soil group for different soil textures (Source USDA-SCS).

HSG	Soil Texture	Type of Soil	Runoff Potential	Remarks
A	Sand, Loamy sand, or Sandy loam	Deep, well-drained sands and gravels	Low	High rate of water transmission
B	Silt loam or loam	Moderately deep, well-drained with moderately fine to coarse textures	Moderate	Moderate rate of water transmission
C	Sandy clay loam	Clay loams, shallow sandy loam, soils with moderately fine to fine textures	Moderately high	Moderate rate of water transmission
D	Clay loam, silty Clay loam, Sandy clay, Silty clay, or Clay	Clay soils that swell significantly when wet, heavy plastic, and soils with a permanent high water table	High	Low rate of water transmission

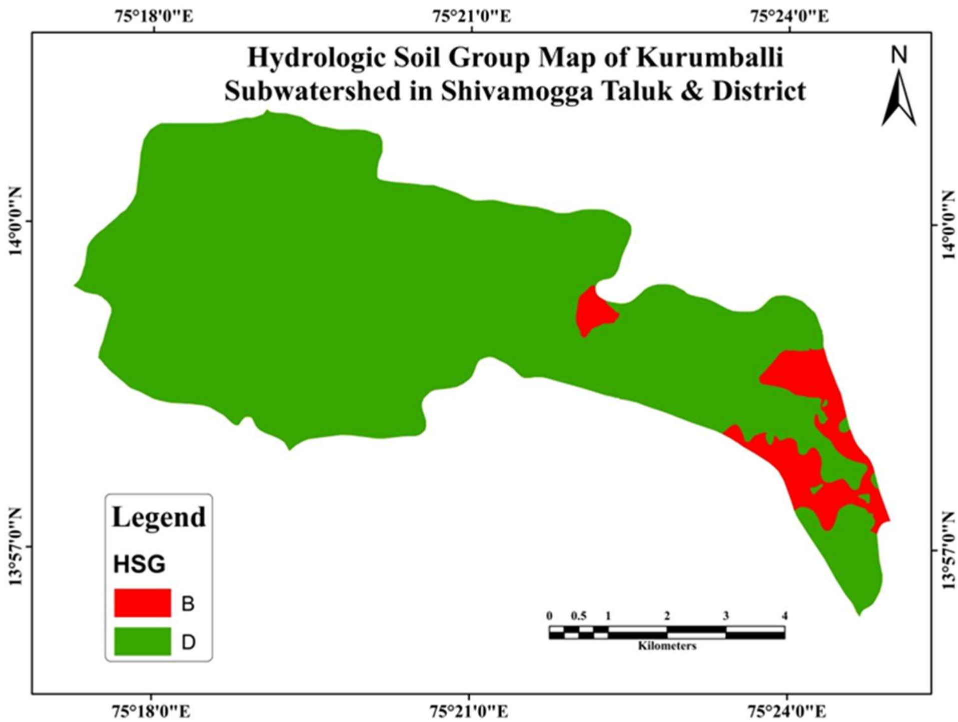

Fig. 4: Hydrologic soil group map of the study area.

and clearing of land for agriculture and development. (NageswaraRao 2020)

Hydrologic Soil Group (HSG)

The hydrological soil group (HSG) is one of the main components used to calculate the curve number (CN). Using the SCS-CN soil classification method, soils were classified into various hydrological groups. Soils are classified into four hydrologic soil groups based on their characteristics: A, B, C, or D tabulated in Table 3. (Tailor et al. 2016). Hydrological soil groups were identified for the Kurumballi sub-watershed based on the USDA-Soil Conservation Service (SCS) guidelines. The HSG classification of soil mainly depends on the infiltration rate of each soil texture category (Karunanidhi et al. 2020). Based on the map of soil textures (Fig. 5), the soil of the Kurumballi sub-watershed was classified into two HSGs: B and D, as shown in Fig. 4. (Al-Ghobari et al. 2022). Group 'D' soil has high runoff potential with prolonged infiltration rates when thoroughly wetted. Moreover, primarily impervious, Group 'B' soil with moderate infiltration rates when thoroughly wetted. (Karunanidhi et al. 2020, Parvez & Inayathulla 2019)

The criteria mentioned in Table 3 are used to calculate HSG based on the soil's surface texture.

Generating Curve Number (CN)

The curve number is a parameter for catchment retention (S) or perviousness. The soil and land use maps were transferred to the Arc GIS to create the CN map. Following the union of two maps with new polygons reflecting the combined soil-land map, the soil map and land use map were chosen for a union. Each polygon on the soil-land map was given the

Table 4: The Weighted CN values obtained for a variety of preceding moisture conditions (AMC).

AMC	Weighted CN value	Potential maximum retention (s)	P > 0.2 S
I	65.14	135.90	27.18
II	81.12	59.12	11.82
III	90.90	25.44	5.09

proper CN value (Fig. 6) (Gajbhiye 2015). The curve number method (USDA 1972) is also known as the hydrologic soil cover complex method, and it is primarily used for estimating surface runoff (Karunanidhi et al. 2020). The CN has the potential to estimate runoff under the same precipitation conditions, and low CN values indicate that the surface has a high potential to retain water (Rawat et al. 2017); in contrast, high values indicate that the land surface can only store a

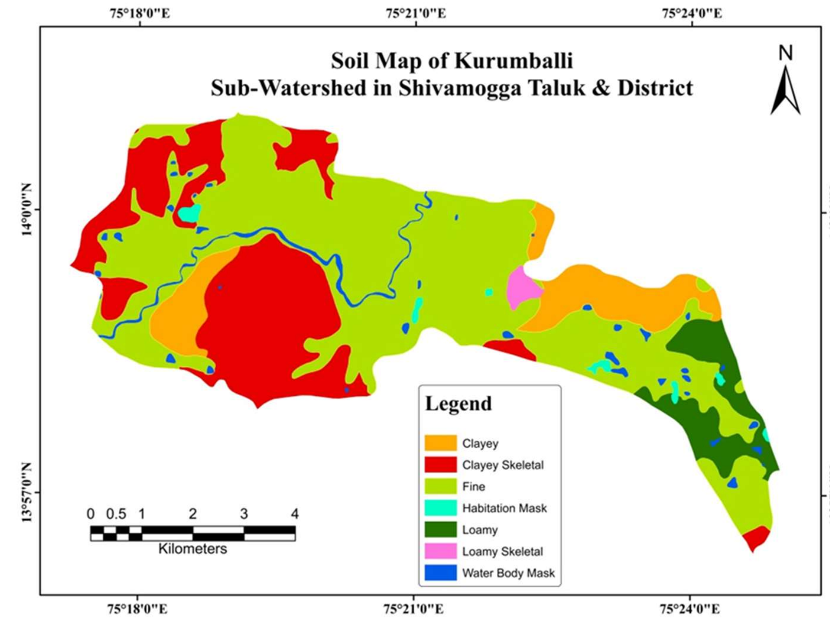

Fig. 5: Soil map of the study area.

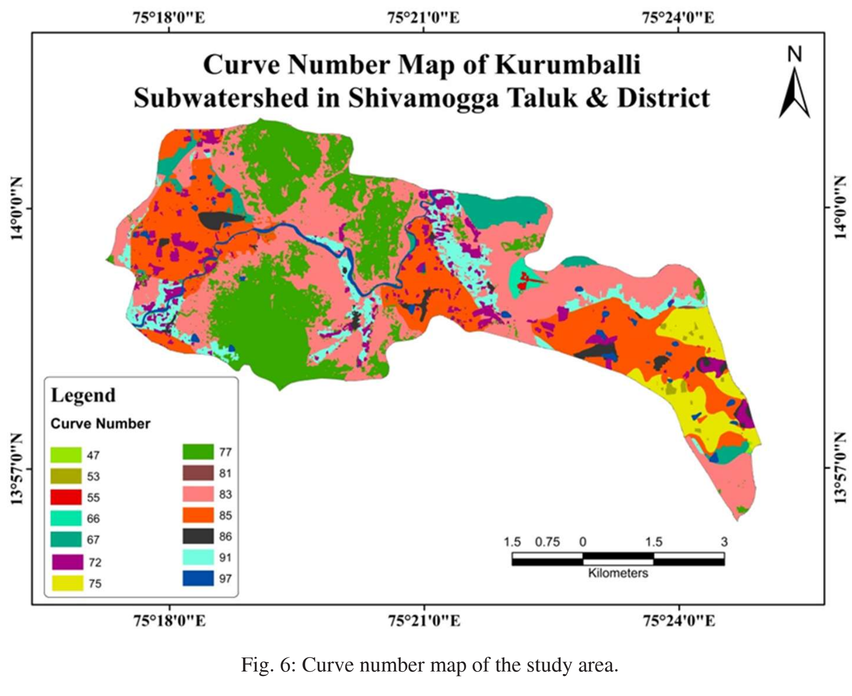

Fig. 6: Curve number map of the study area.

Table 5: Result of Rainfall-Runoff.

Years	Rainfall in mm	Runoff in mm
2011	102.9	54.97
2012	88.4	42.97
2013	112.0	62.75
2014	138.6	86.12
2015	75.9	33.14
2016	73.0	30.89
2017	96.3	49.43
2018	108.4	59.67

small amount of rainfall. As a result, areas with a high CN value will generate a large amount of direct runoff (Rawat et al. 2017). The Weighted CN values obtained for a variety of preceding moisture conditions (AMC) are shown in Table 4.

Data on daily precipitation from the years 2011 to 2018 have been examined. For the years 2011 to 2018, the Kurumballi sub-watersheds yearly rainfall and runoff are displayed in Table 5. The maximum predicted runoff for the watershed was 0.68 mm in 2014, and the minimum was 0.51 mm in 2016, as depicted in Fig. 7 and Table 5 (Tailor & Shrimali 2016). Moreover, the calculation of surface runoff

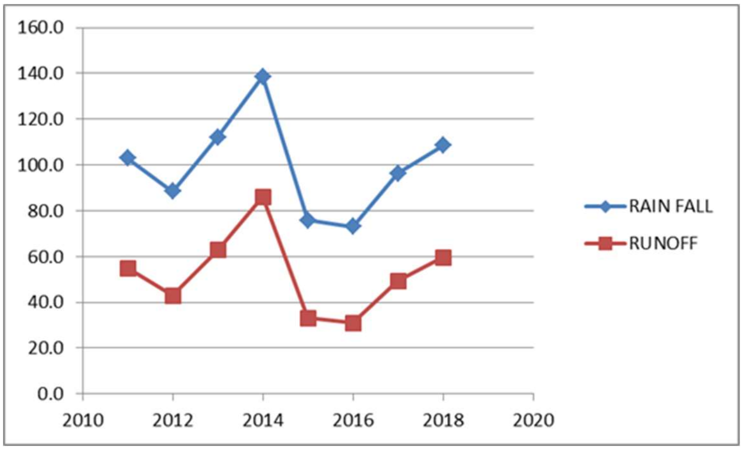

Fig. 7: Graphical plot showing the yearly variation of rainfall and runoff.

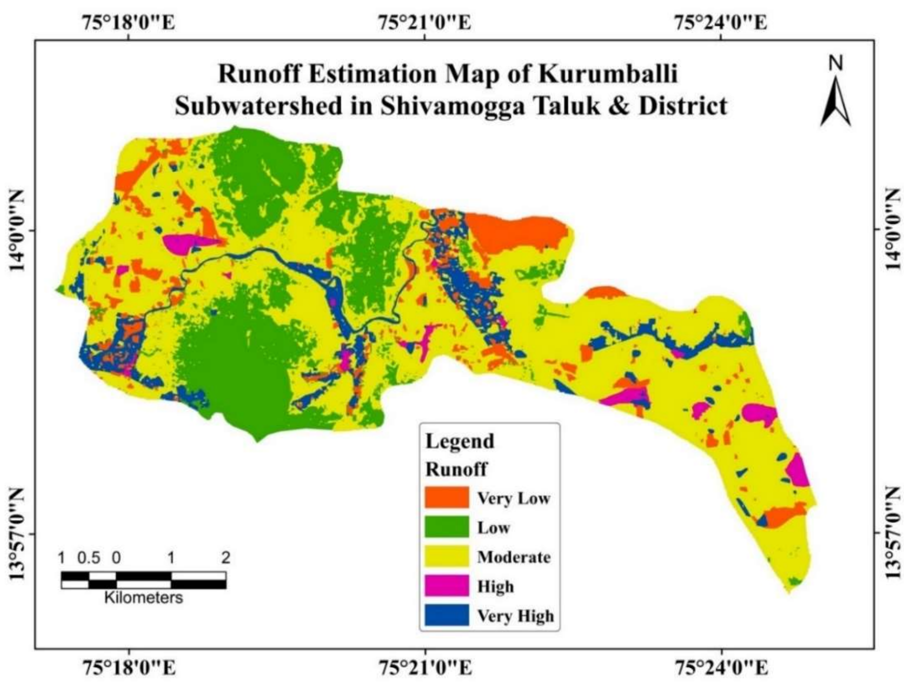

Fig. 8: Runoff estimation map using SCS-CN method.

using the SCS-CN method for the study area is summarized in Table 6.

Calculation of Surface Runoff Using SCS-CN Method

After performing calculations using formulas 5, 6, and 7, we could precisely estimate the amount of runoff in the study area. This estimation was done using the SCS-CN method, and we created a detailed Runoff estimation map to illustrate the results (Fig. 8).

Runoff Potential Zonation Mapping Using Thematic Integration

Runoff Potential Zones were identified for the study area using thematic layers such as lithology, geomorphology, soil,

Table 6: Runoff estimation of the study area using the SCS-CN Method.

Different Land use classes	Soil type	HSG	CN	Area Sq. km	% Area	% Area * CN	Weighted CN	Specific retention	Runoff depth	Runoff Volume in m^3
Kharif	Waterbody Mask	D	85	0.377	0.79	67.10	83	52.02	56.51	2693961.18
	Fine	D	85	8.513	17.82	1515.09				
	Clayey Skeletal	D	85	1.111	2.33	197.73				
	Clayey	D	85	0.219	0.46	38.98				
	Loamy	B	75	2.573	5.39	404.05				
	Habitation Mask	D	85	0.2528	0.53	44.99				
					27.32	2267.93				
Encroachment	Waterbody Mask	D	91	0.101	0.21	19.22	91	25.12	74.92	3571537.54
	Fine	D	91	2.275	4.76	433.47				
	Clayey Skeletal	D	91	0.299	0.63	56.97				
	Clayey	D	91	0.355	0.74	67.65				
	Loamy	B	81	0.020	0.04	3.36				
	Habitation Mask	D	91	0.002	0.0046	0.42				
					6.39	581.08				
Forest Plantation	Waterbody Mask	D	77	0.032	0.07	5.17	77	75.87	44.62	2127248.61
	Fine	D	77	5.462	11.44	880.61				
	Clayey Skeletal	D	77	4.573	9.58	737.34				
	Clayey	D	77	0.601	1.26	96.88				
	Loamy	B	55	0.062	0.13	7.08				
	Habitation Mask	D	77	0.001	0.0011	0.09				
					22.47	1727.17				
Plantation	Waterbody Mask	D	72	0.113	0.236	16.99	71	104.26	34.02	1621805.98
	Fine	D	72	2.045	4.283	308.34				
	Clayey Skeletal	D	72	0.258	0.539	38.83				
	Clayey	D	72	0.015	0.031	2.22				
	Loamy	B	53	0.151	0.315	16.70				
	Habitation Mask	D	72	0.013	0.027	1.94				
					5.431	385.03				
Scrub forest	Waterbody Mask	D	67	0.023	0.048	3.25	67	126.119	27.71	1321139.34
	Fine	D	67	1.294	2.710	181.57				
	Clayey Skeletal	D	67	0.342	0.716	47.98				
	Clayey	D	67	0.232	0.485	32.52				
	Loamy	B	47	0.017	0.036	1.68				
					3.996	266.99				
Settlements	Waterbody Mask	D	86	0.061	0.128	11.01	83	50.553	57.36	2734469.32
	Fine	D	86	0.693	1.451	124.81				
	Clayey Skeletal	D	86	0.087	0.182	15.64				
	Clayey	D	86	0.046	0.097	8.32				
	Loamy	B	72	0.277	0.580	41.78				
	Habitation Mask	D	86	0.328	0.688	59.13				
					3.126	260.70				

Table Cont....

Different Land use classes	Soil type	HSG	CN	Area Sq. km	% Area	% Area * CN	Weighted CN	Specific retention	Runoff depth	Runoff Volume in m^3
Degraded Forest	Waterbody Mask	D	83	0.212	0.444	36.83	82.06	53.27	55.81	2660335.37
	Fine	D	83	4.260	8.919	740.32				
	Clayey Skeletal	D	83	6.927	14.504	1203.83				
	Clayey	D	83	3.409	7.138	592.47				
	Loamy	B	66	0.005	0.011	0.73				
	Loamy Skeletal	B	66	0.293	0.614	40.50				
	Habitation Mask	D	83	0.018	0.038	3.12				
					31.668	2617.79				
Waterbody	Waterbody Mask	D	97	0.242	0.507	49.19	97	7.86	90.26	4336010.50
	Fine	D	97	0.739	1.547	150.09				
	Clayey Skeletal	D	97	0.048	0.101	9.75				
	Clayey	D	97	0.021	0.043	4.20				
	Loamy	B	97	0.060	0.126	12.23				
	Habitation Mask	D	97	0.005	0.010	0.95				
					2.334	226.41				

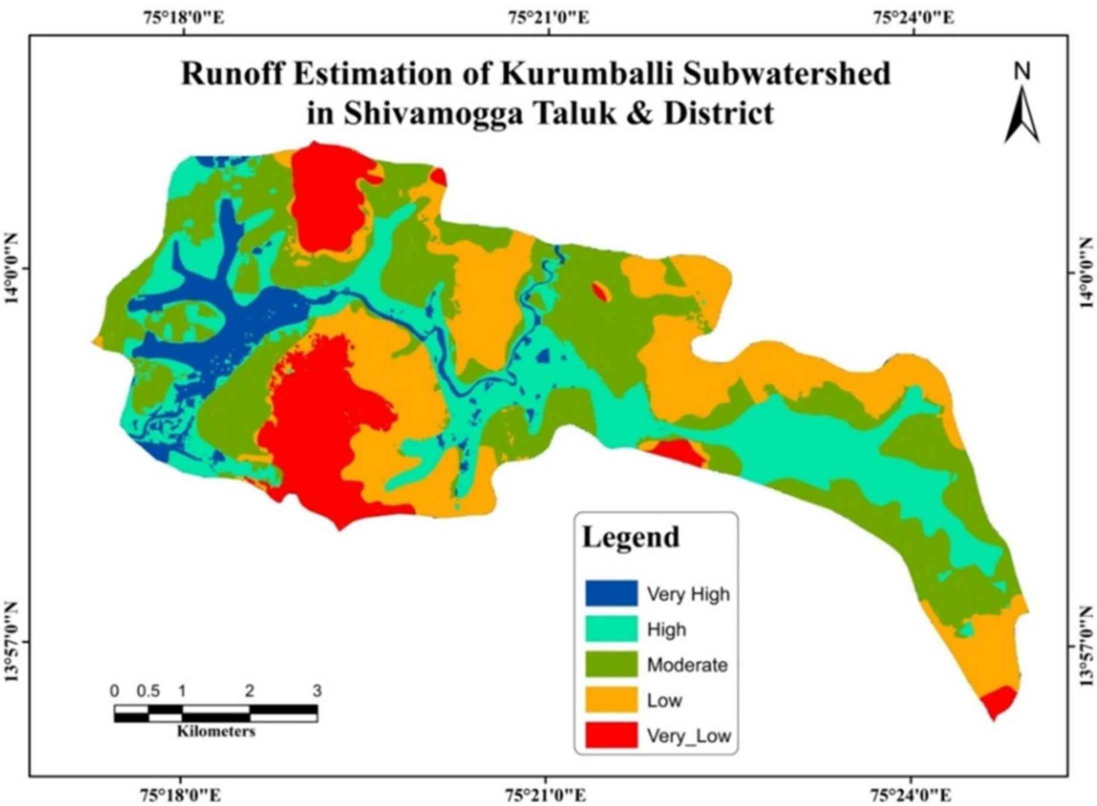

Fig. 9: Runoff potential zonation map using Thematic-integration.

slope, land use, drainage, surface water bodies, groundwater contour, and isohyetal maps. These thematic layers were combined using the ArcGIS 10.4 program to delineate probable zones (Fig. 9). The weights of the various themes were allocated based on their impact on the runoff potential. Weights were given to various aspects of each topic based on how much of an impact they had on the runoff potential. Based on this assessment, several aspects of the classes were assessed as Very high (7%), High (24%), Moderate (33%), Low (25%), and Very Low (11%). All thematic layers were then combined after weighting to demarcate potential runoff zones.

CONCLUSIONS

The runoff generation process is highly complex, nonlinear, and dynamic, with numerous interconnected physical factors influencing it. Therefore, precise runoff estimation is carried out for efficient water resource management and growth. There are numerous methods for estimating runoff from rainfall; however, the SCS-CN method remains the most popular, fruitful, and widely used method. The SCS-CN method relies on runoff curve number (CN), determined by land use/land cover (LULC), soil type, Antecedent Moisture condition, and Hydrological soil group. In this study, the SCS runoff curve number for the Kurumballi sub-watershed is estimated using the SCS runoff curve number method, which involves a GIS-based union of the land use land cover map and the hydrologic soil group. First, soil classification results classified the study area into two HSGs (B and D). Group D was the dominant HSG. After that, the estimated curve number is validated using rainfall-runoff data. The total volume of surface runoff in the study area is 21065849.7 m^3. Runoff estimation was also performed using thematic layers such as Lithology, Geomorphology, Soil, Slope, Land Use and Land Cover, drainage and Surface water bodies, Groundwater Contour, and Isohyet maps for the delineation of runoff Potential Zones for the study area, which is more accurately correlates with the SCS-CN method. The present study shows that the combination of SCS-CN number and weighted overlay analysis methods is most suitable and accurate for surface runoff potential assessment.

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