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RESEARCH PAPER

# Goolge Earth Engine-based Rainfall-Runoff Modelling for Hydrological Assessment in Rasulpur River Basin

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**Abstract**

The hydrological assessment of surface rainfall-runoff is crucial for effective water resource management and flood risk mitigation. Using the SCS-CN method, this study combined remote sensing GIS, and Google Earth Engine (GEE) methods to give an occupied hydrological assessment. GEE facilitated the processing of large-scale environmental data and facilitated large details of run-off properties, land used dynamics, and rainfall patterns. Following the study, there was an overall rise in runoff with rainfall for the years 2019 to 2022. For watersheds I, II, and III, the AMC results were 71.220, 74.990, and 33.330 for normal condition (CNII), dry condition (CNI), 50.965, 55.739, 17.353, and wet condition (CNIII), 85.056, 87.336, and 53.485, respectively. From 2019 to 2021, the average annual rainfall, volume of run-off, and run-off co-efficient are 10040.371 mm, 7728.371 mm$^3$, and 0.764 mm respectively. The annual rainfall-run-off ratio is significantly increased in the years 2019 and 2021, but in 2022, are decreased. There is a strong relationship between total rainfall and run-off in the contain, with a correlation coefficient (r) value is 0.99. The Rasulpur River basin's hydrological behaviour was able to be accurately and recently assessed thanks to the use of high-resolution, real-time satellite data and it is a valuable tool for informed decision-making and the development of sustainable water resource management strategies.

**Keywords:** Remote Sensing; Geographic Information System; SCS-CN; Rainfall-runoff Modelling; Sustainable Water Resource.

## 1. Introduction

Comprehensive hydrological assessments are becoming more and more dependent on the incorporation of new technology as the demand for sustainable management of water resources grows globally. Researchers suggested the estimation of surface run-off by taking into account factors including soil, antecedent moisture content (AMC), land use and land cover (LULC) type, and spatial distribution [1]. Another research reported the cloud-based computing platform, GEE, integrates publicly available remote sensing and geographic information systems datasets with Google's computational resources [2]. Hydrological assessments serve as a cornerstone in understanding the intricate dynamics of watersheds, providing crucial insights for effective water resource planning and management. The Rasulpur River Basin, chosen as our case study, presents a microcosm of diverse environmental variables, ranging from topographical features to land cover dynamics. By leveraging the cloud-based capabilities of GEE, we aim to transcend traditional limitations in processing vast and complex datasets, facilitating an in-depth exploration of the basin's hydrological intricacies. Research suggested that estimating run-off are input reliable input parameters such as; Rainfall used dynamics, soil type, and antecedent moisture that can be obtained at regional to global scale using verities of Landsat, TRMM, and IRS data [3]. A group of researchers reported several tools and software have been for developed collecting and analysing of Remote Sensing and GIS data of established rainfall-run-off modelling [4]. The integration of GEE, Remote Sensing, and GIS techniques holds the promise of enhancing both the spatial and temporal resolution of our analyses. Remote Sensing offers a bird's-eye view of the landscape, enabling the extraction of essential information regarding land cover, vegetation indices, and surface characteristics. GIS techniques further complement this by providing a spatial framework for organizing, analysing, and visualizing the multifaceted data layers. In the field of hydrology, GEE is used for a numerous purpose, including researching water, snow, and glaciers suggested [5], monitoring reservoir or lake dynamics [6], monitoring surface water dynamics Murphy [7], [8], researchers proposed that using GEE to predict surface run-off for any catchment area while taking the SCS-CN techniques to take into account of LULC dynamics, rainfall patterns, soil types and AMC [8]. A survey of the literature reveals that no research has been done so far to estimate surface run-off using big data on GEE [9]. In this study, the CN-based rainfall—run-off algorithm created in JavaScript is used to estimate run-off at basin/sub-basin sizes using the public archive database and geospatial cloud computation technology of GEE. The SCS-CN method, a widely acknowledged approach in hydrological modelling, will be the linchpin in our rainfall-runoff simulations. By applying this method to the Rasulpur River Basin, we seek to unravel the basin's response to precipitation events, contributing valuable insights into the hydrological processes that govern runoff generation. This research endeavours not only to advance the methodological frontier in hydrological modelling but also to contribute actionable knowledge for water resource planners, environmental scientists, and policymakers. Through the lens of the Rasulpur River Basin, we aim to demonstrate the efficacy of this integrated approach and illuminate pathways for future advancements in the sustainable management of water resources within complex and dynamic watershed systems.

## 2. 2. Literature Review

Hydrological assessment, crucial for effective water resource management, has significantly benefited from advancements in geospatial technologies such as remote sensing, Geographic Information Systems (GIS), and cloud-based computation platforms like GEE. Remote sensing technologies, including optical and radar imagery, have been extensively utilized in hydrological modelling to capture spatial data on land cover, vegetation dynamics, and surface properties. Researchers in investigations of rainfall-runoff, and remote sensing technologies can greatly enhance the traditional approaches. In runoff calculations, remote sensing is typically used as a source of input data or as a tool to help estimate model parameters and equation coefficients [10]. Another research Compared to traditional procedures, remote sensing techniques are speedier, more modern, and more dependable [11]. It is crucial to the collection of data on the various facets of land use and soil cover, as they are key factors in the estimation of watershed run-off. A group of researchers suggested hydrological modelling that considers the effects of land use and climate on surface water balance can be used to estimate surface runoff with accuracy [12]. Research outcomes for determining runoff and river catchment features like land use/cover, slope, etc., RS and GIS are appropriate methods. Run-off estimation is made faster and more precise by combining the RS, GIS, and SCS models [7]. GEE is a web-accessible cloud-based platform designed for planetary-scale geospatial analysis aimed at resolving various high-impact societal problems.

With its state-of-the-art capabilities, GEE can handle disaster management, LULC mapping, and earth scientific applications worldwide. GEE is also capable of handling dynamic data, which is otherwise not possible using the presently available models. GEE has emerged as a powerful tool for water resources management and hydrological studies due to its handling capacity of a large set of data through cloud computing. The Soil Conservation Service Curve Number (SCS-CN) method is a widely used empirical approach for estimating runoff from precipitation events. For runoff estimation, the curve number method [13] is a flexible and popular approach. According to research this approach takes into account the antecedent soil water conditions, land use, and soil permeability as significant watershed features [14]. The most straightforward method to determine for estimating the amount of run-off that will gate from the various parameters such as LULC, rainfall, topography, and soil types concern [15]. In some research conducted in earlier studies, the four main features of watersheds that produce runoff are soil type, land use, hydrologic condition, and antecedent moisture condition (AMC) [11], [13], [16], [17], [18], [19], [20]. The SCS-CN technique takes three parameters such as; AMC is classified into three levels, AMC I(dry condition), AMC II (Normal condition), and AMC III (Wet condition), based on the staties that correlated to the 10,50 and 90% cumulative risk of excess of run-off, soil types, and LULC dynamics [21]. The main novelty of the research is to find out the Rasulpur River Basin Using the SCS-CN Method for Rainfall-Runoff Modelling through a GEE-based application which is not estimated before. This study analysis can help for regional planning and management. In summary, previous literature demonstrates the potential of integrating GEE with remote sensing and GIS techniques for hydrological assessment, with the SCS-CN method serving as a practical approach for simulating rainfall-runoff processes. Through this literature review, we aim to provide a comprehensive understanding of the theoretical foundations and practical applications of integrated geospatial approaches for hydrological modelling, laying the groundwork for our case study in the Rasulpur River Basin.

## 3. Study Area

The Rasulpur River Basin serves as a compelling study area for hydrological research due to its diverse environmental characteristics and significance in the context of water resource management. The study area extended 21°41'21.282"N to 22°10'36.12"N Latitudes and 87°21'33.402"E to 87°57'18.086"E Longitudes and the area have 1561.860 $km^2$, the basin encapsulates a range of features that make it an ideal site for investigating the interplay of natural elements within a watershed. The tributaries of Rasulpur river are Itaberia khal, Mugberia khal, Palabani khal, padurbheri khal and Alipur khal and joins the Bay of Bengal, presently subsequently Petua Ghat Ghat, a fishing harbour just before the estuary of the river. (Figure 1).

## 4. Materials and methodology

Integrating GEE Cloud-Based Hydrological Assessment with Remote Sensing and GIS and SCS CN model used different cloud data availability in the GEE server. The finalized methodological flowchart to use dynamic LULC (Landsat 8 OLI satellite data-2022), rainfall (CHIRPS Pentad: Climate Hazards Group Infrared Precipitation with Station Data, 2019 - 2022 (https://www.chc.ucsb.edu/data/chirps) [22], Global Soil data (Open Land Map Soil Texture Class-USDA System (https://developers.google.com/earthengine/datasets/catalog/OpenLandMap$_SOL_SOL_TEXTURE-CLASS_USDA-TT_{Mv}$02)[9] and Rasulpur Basin map (Irrigation & Waterways Directorate) Annual report-2017 (https://wbiwd.gov.in/).

### *4.1 SCS-CN Model*

Based on the National Engineering Handbook (NEH-4) Section of Hydrology [23], the SCS-CN approach was developed in 1954 by the USDA SCS [24]. Calculate the weighted Curve Number (CN) for the entire watershed by taking into account the area covered by each land use or land cover class. The weighted CN value is calculated as the sum of the product of the area of each land use class and its corresponding CN value, divided by the total watershed area [25], [26].

$$S = \frac{1000}{CN} - 10 \qquad (1)$$

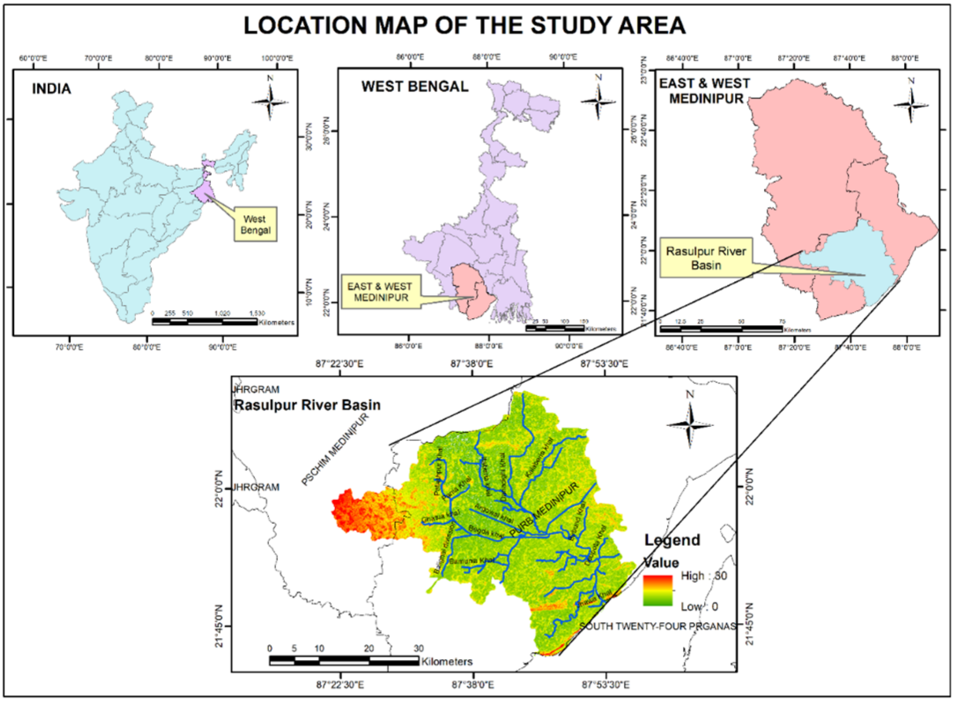


**Figure 1:** *Location map of the study area.*

$$CN = \frac{1000}{S + 10} \tag{2}$$

$$CN = \frac{25400}{S + 254} \tag{3}$$

$$S = \frac{25400}{CN} - 254 \tag{4}$$

**Estimation of the potential maximum retention,** S in a watershed is very difficult as it depends on the characteristics of soil-vegetation-land use (SVL) complex and antecedent soil-moisture conditions (AMC). The Soil Conservation Service (SCS) expressed S as a function of curve number as:

Where, CN is a dimensionless number ranging from 0-100, S is in inches (Eq-1). For the SI unit of S (mm) the (Eq.-3). It is established by considering AMC, LULC, and hydrological soil groups.

The water equilibrium calculation is the basis for the SCS and CN technique, and two basic and important assumptions have been proposed [27]. The SCS CN method considers the antecedent moisture conditions, which represent the moisture content of the soil before a rainfall event. It is divided into three categories: Dry, Average, and Wet. Select the appropriate category based on recent rainfall history or use historical data if available. The AMC-I and AMC-III examples use the following equations [28].

The CN values documented for the case of AMC-II [17]. To adjust the CN for the cases of AMC-I (Eq.-5) and AMC-III (Eq.-6), the following equations are used for Hydrological Condition:

$$CN(I) = \frac{4.2 * CN(II)}{10 - (0.058 * CN(II))} \tag{5}$$

$$CN(III) = \frac{23 * CN(II)}{10 + (0.13 * CN(II))} \tag{6}$$

Where CN (II), (I), (III) represents the normal condition, normal condition and Wet condition respectively.

### 4.2 Estimate Runoff

Once the Curve Number is determined, it is used to estimate the direct runoff volume from a rainfall event. Rainfall data for the desired duration should be available. The SCS CN method uses the formula:

$$\text{Runoff}(Q) = (P - 0.2\ S)^2/(P + 0.8\ S) \tag{7}$$

Where P is the precipitation and S is the potential maximum retention after runoff begins, calculated as (1000 / CN) - 10. The resulting runoff value represents the estimated volume of direct runoff generated by the rainfall event.

Where S is the watershed storage mm; Q is the actual direct runoff; and P is the total rainfall mm.

### 4.3 Weighted CN

Weighted CN = ( Area of land *CN) + ( Area of land *CN) + . . . . . . ..( Area of land *CN)/ Total area of the watershed A total area of the watershed. When runoff starts, the potential maximum retention (S) is found from the (Eq.-4). To compute the surface runoff depth, apply the hydrological equations from (Eq.-5) and (Eq.-6). These equations depend on the value of rainfall (P) and watershed storage (S) which are calculated from the familiar curve number. According to antecedent soil moisture condition (AMC) and land use/cover (LULC), the SCS curve number measures a soil's capacity to permit water infiltration [29].

Therefore, before applying equation (Eq.-3) the value of (S) must be determined for every antecedent moisture condition (AMC) as mentioned below (Figure 2). There are three hydrologic conditions results summarized in Table 1.

**Table 1:** *Antecedent moisture rainfall in mm*

| AMC | Dormant Season | Growing Season |
|---|---|---|
| I (Dry) | <12.7 | <35.6 |
| II (Normal) | 12.7 – 27.9 | 35.6 – 53.3 |
| III (Wet) | >27.9 | >53.3 |

## 5. Result and Discussion

The potential maximum retention parameter (S) varies both temporally due to variations in soil water content and slope caused by changes in land use. For ease of evaluating land usage, conservation techniques, soil conditions, and previous rainfall [30]. According to the US-SCS, soils are classified into four HSG, A, B, C, and D, based on the capacity for infiltration and runoff rate.

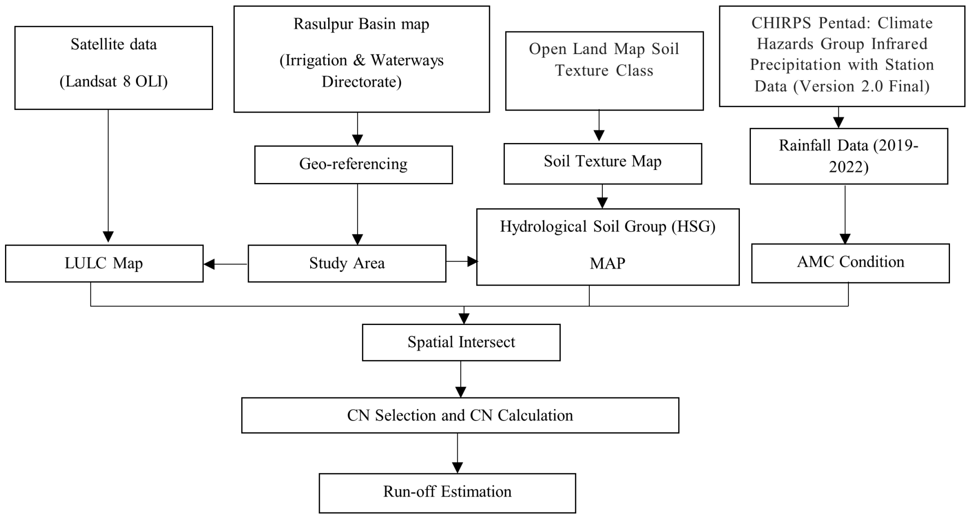


**Figure 2:** *Methodological Flow Chart of the Study.*

## 5.1 LULC and HSGs

The hydrological soil textural grouping map that was georeferenced, digitized projected, and obtained from the GEE platforms with shown Figures 3, 4, and 5. The soil group A showed that water infiltrated moderately to the well-drained and D soil group id a moderately fine to rough texture that was water moderately transmitted.

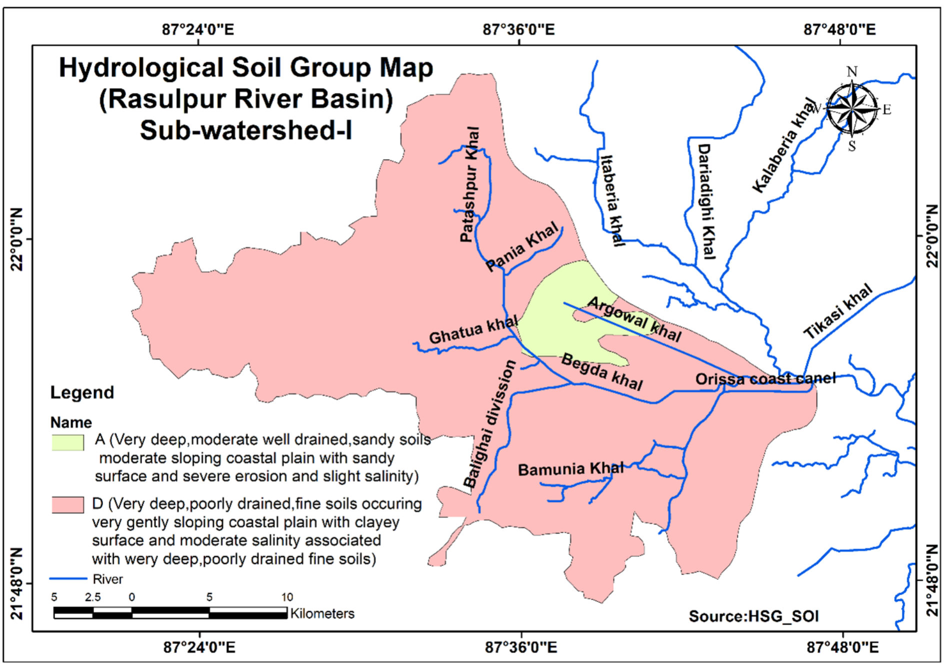


**Figure 3:** *HSG Map (W-I) of the Study area.*

**Table 2:** *Classification of Hydrological Soil groups with determinate CN along LULC categories of Water bodies-I*

| Soil group-D | | | | |
|---|---|---|---|---|
| Class name | area in $m^2$ | area in $km^2$ | CN | (Area*CN)/TA |
| Water bodies | 117693000 | 117.693 | 100 | 20.170 |
| Settlements | 158610000 | 158.61 | 92 | 25.008 |
| vegetation | 106712000 | 106.712 | 61 | 11.156 |
| Barren | 13347000 | 13.347 | 89 | 2.036 |
| Agricultural | 187132000 | 187.132 | 87 | 27.902 |
| Total area | | 583.494 | | 86.272 |
| Soil group-A | | | | |
| Class name | area in $m^2$ | area in $km^2$ | CN | (Area*CN)/TA |
| Water bodies | 10485900 | 10.4859 | 100 | 31.325 |
| Settlements | 13108500 | 13.1085 | 77 | 30.153 |
| vegetation | 4563900 | 4.5639 | 26 | 3.545 |
| Barren | 358200 | 0.3582 | 68 | 0.728 |
| Agricultural | 4958100 | 4.9581 | 67 | 9.924 |
| Total area | | 33.4746 | | 75.674 |
| The total area of Sub watershed-I | | | 2145.353 | |
| Ultimate Curve No | | | 71.22684 | |
| Approx.CN (II) | | | 71.23 | |
| Hydrological Condition for Watershed-I | | | | |
| CN (I) | 50.965 | | Dry Condition | |
| CN (III) | 85.056 | | Wet Condition | |

**Table 3:** *Classification of Hydrological Soil groups with determinate CN along LULC categories of Water bodies-II*

| | | | | |
|---|---|---|---|---|
| Soil group-D | | | | |
| Class name | area in $m^2$ | area in $km^2$ | CN | (Area*CN)/TA |
| Water bodies | 85928400 | 85.9284 | 100 | 16.379 |
| Settlements | 102847000 | 102.847 | 92 | 18.036 |
| vegetation | 144858000 | 144.858 | 61 | 16.843 |
| Barren lands | 9111600 | 9.1116 | 89 | 1.546 |
| Agricultural lands | 181879000 | 181.879 | 87 | 30.162 |
| Total Area | | 524.624 | | 82.965 |
| Soil group-A | | | | |
| Class name | area in $m^2$ | area in $km^2$ | CN | (Area*CN)/TA |
| Water bodies | 1026000 | 1.026 | 100 | 38.934 |
| Settlements | 1059300 | 1.0593 | 77 | 30.953 |
| vegetation | 167400 | 0.1674 | 26 | 1.652 |
| Barren lands | 80100 | 0.0801 | 68 | 2.067 |
| Agricultural lands | 302400 | 0.3024 | 67 | 7.689 |
| Total Area | | 2.6352 | | 81.294 |
| The total area of Sub watershed-II | | | 3123.7184 | |
| Ultimate Curve No | | | 74.998 | |
| Approx.CN | | | 75 | |
| Hydrological Condition for Watershed-II | | | | |
| CN (I) | 55.739 | | Dry Condition | |
| CN (III) | 87.336 | | Wet Condition | |

**Table 4:** *Classification of Hydrological Soil groups with determinate CN along LULC categories of Water bodies-III*

| Soil group-D | | | | |
|---|---|---|---|---|
| Class name | area in $m^2$ | area in $km^2$ | CN | (Area*CN)/TA |
| Water bodies | 69265800 | 69.2658 | 100 | 17.514 |
| Settlements | 62267400 | 62.2674 | 92 | 14.485 |
| vegetation | 105812000 | 105.812 | 61 | 16.321 |
| Barren lands | 8903700 | 8.9037 | 89 | 2.004 |
| Agricultural lands | 149230000 | 149.23 | 87 | 32.829 |
| Total Area | | 395.4789 | | 83.153 |
| Soil group-A | | | | |
| Class name | area in $m^2$ | area in $km^2$ | CN | (Area*CN)/TA |
| Water bodies | 3518100 | 3.5181 | 100 | 15.881 |
| Settlements | 4660200 | 4.6602 | 77 | 16.198 |
| vegetation | 7066800 | 7.0668 | 26 | 8.294 |
| Barren lands | 741600 | 0.7416 | 68 | 2.276 |
| Agricultural lands | 6166800 | 6.1668 | 67 | 18.651 |
| Total Area | | 22.1535 | | 61.299 |
| The total area of Sub watershed-III | | | 3123.718 | |
| Ultimate Curve No | | | 33.330 | |
| Approx.CN | | | 33.000 | |
| Hydrological Condition for Watershed-III | | | | |
| CN (I) | 17.353 | | Dry Condition | |
| CN (III) | 53.485 | | Wet Condition | |

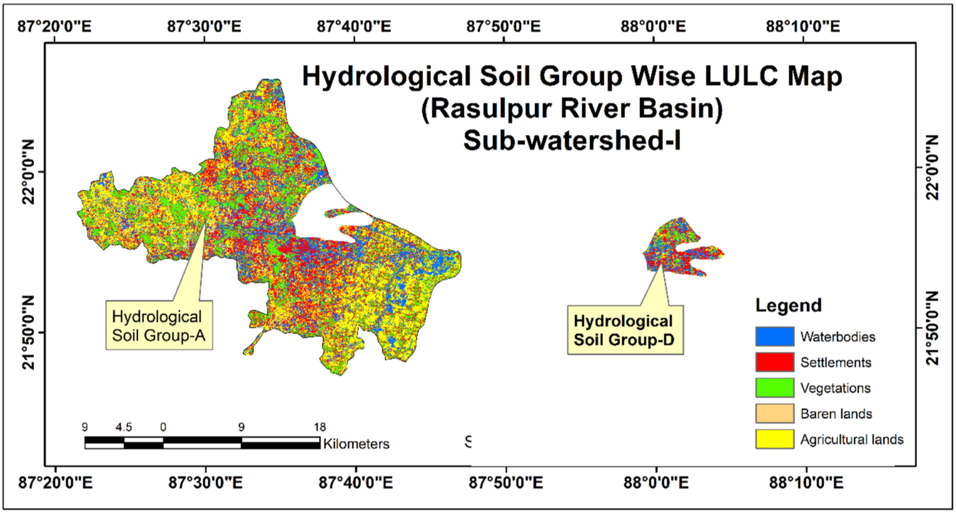


**Figure 4:** *HSG with LULC Map (W-I) of the Study area.*

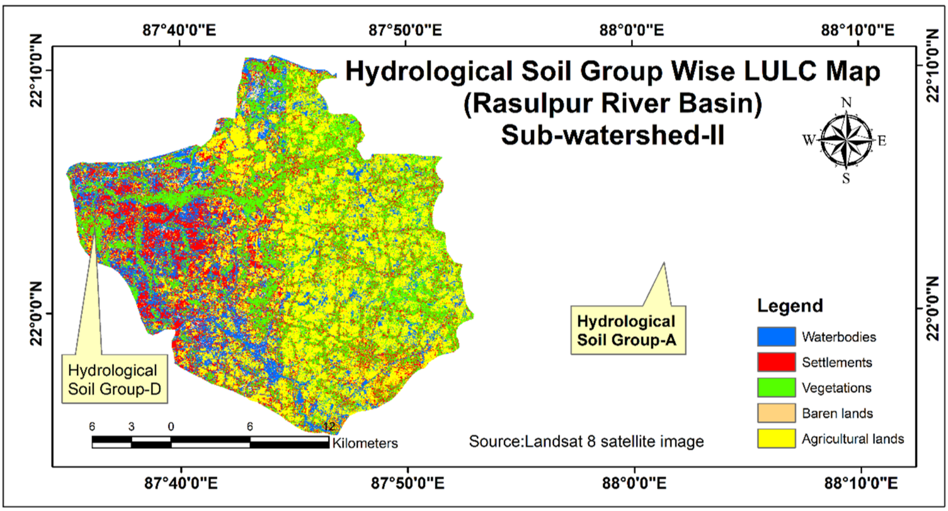


**Figure 5:** *HSG with LULC Map (W-II) of the Study area.*

### 5.2 Antecedent Moisture Condition (AMC)

It is measured when little prior precipitation and high when there has been significant earlier rainfall to the modelled rainfall event. For modelling purposes, AMC II in the watershed is mostly a normal moisture condition. Runoff curve numbers from LULC (Figure 6, 7, and 8; Table 2, and 3) and soil type (Figure 9, 10, and 11; Table 4, and 5) involved for the normal condition (AMC II) and dry conditions (AMC I) or wet condition (AMC III), related CN can be processed with the aid of the accompanying equations. The acknowledged CN values in the AMC II scenario [16]. The accompanying equations are used in the cases of AMC-I and AMC-III [25].

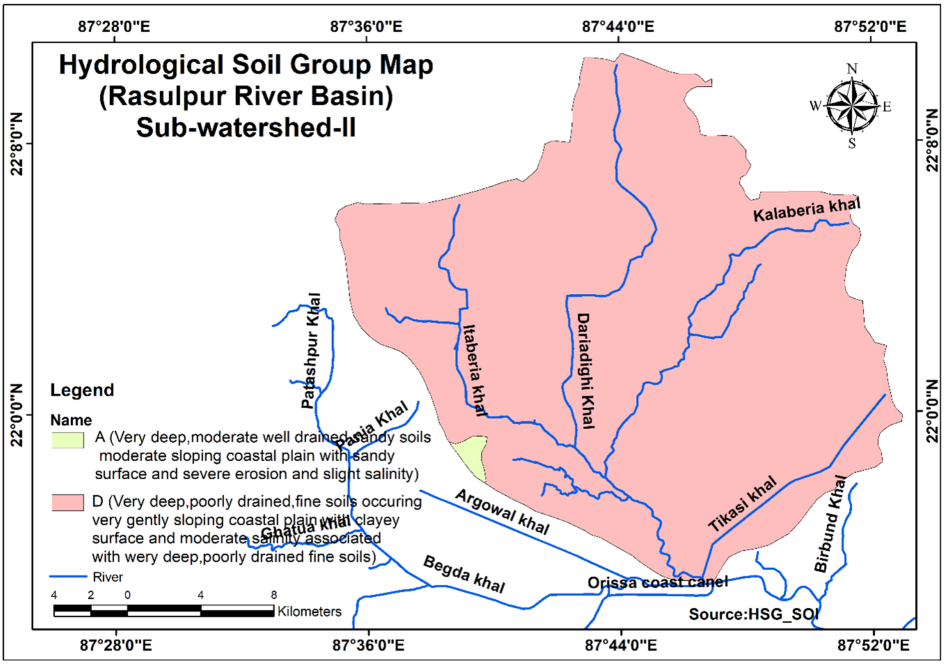


**Figure 6:** *HSG Map (W-II) of the Study area.*

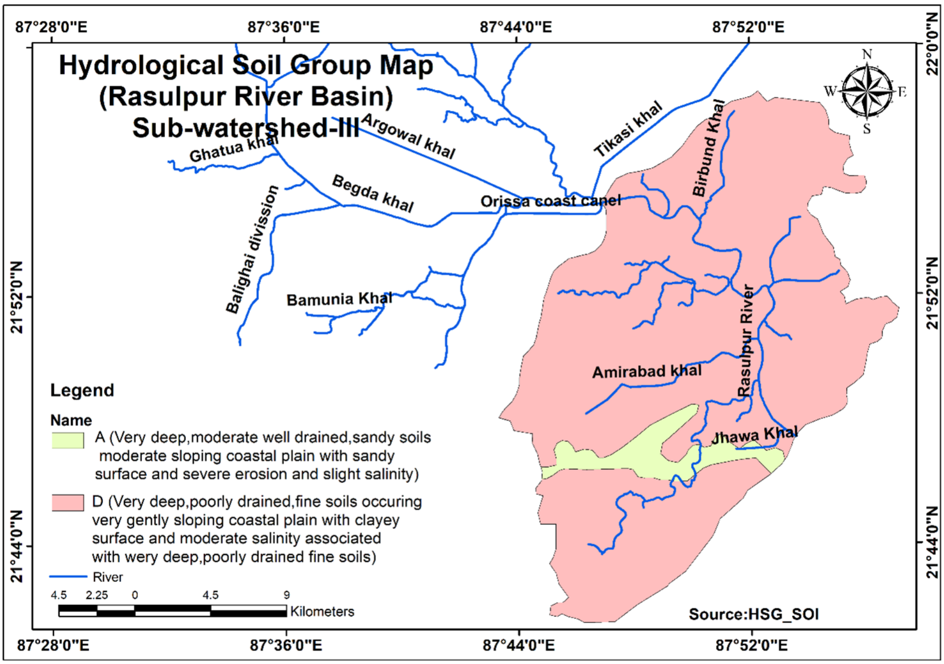


**Figure 7:** *HSG Map (W-III) of the Study area*

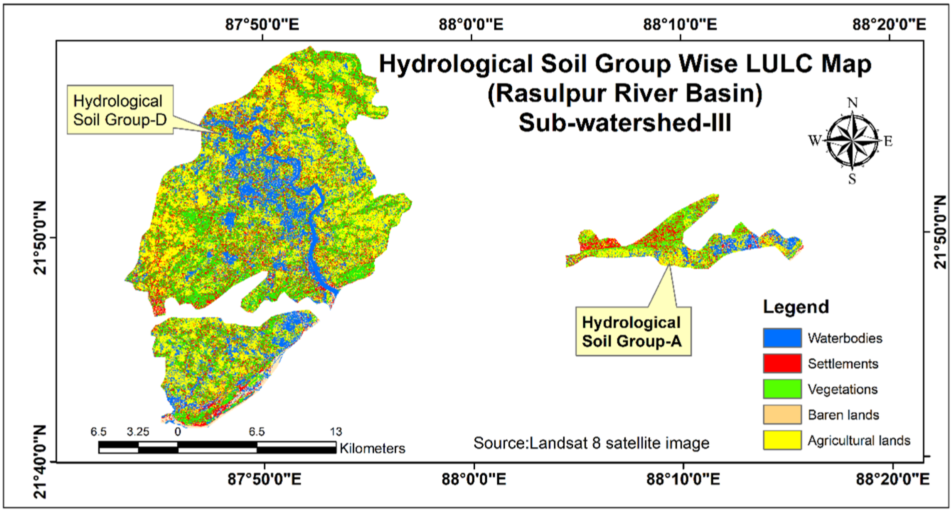


**Figure 8:** *HSG with LULC Map (W-III) of the Study area.*

## 5.3 Rainfall-Runoff of Rasulpur River Basin

Rasulpur river basin falls under nearly level to moderate steep slope class (low to high surface runoff) representative water holding for a longer time and therefore improving the possibility of infiltration and recharge in this study area. By applying the SCS-CN method, the overall study results are as follows average annual surface volume of run-off depth for the four years in the Rasulpur river basin is 7728.371 mm$^3$ (Figure 9). The LULC dynamics, Hydrological Soil Groups, and CN is shown in table 2,3,4 and the rainfall and run-off co-efficient 0.764 are strongly correlated in the study. Table 5 shows, the annual real rainfall (mm), run-off coefficient (mm), and volume of run-off depth (mm), and these are strong relationships among the rainfall and run-off, evidenced by the correlation coefficient value is 0.99.

**Table 5:** *Annual actual Rainfall (mm), volume of Run-off depth (mm), Run-off Coefficient (mm) of the Rasulpur river basin.*

| Sl. No. | Years | Rainfall (mm) | Watershed-I Area=616.969 km$^2$ | Run-off (mm)$^3$ Watershed-II Area=527.259 km$^2$ | Watershed-III 417.632 km$^2$ | Average Grand Total Volume of Run-off (mm)$^3$ | Run-off Co-efficient =Q Run-off/P rainfall (mm)$^3$ |
|---|---|---|---|---|---|---|---|
| 1. | 2019 | 9421.31 | 7647.025 | 7827.648 | 5361.846 | 6945.506 | 0.737 |
| 2. | 2020 | 9812.335 | 8025.78 | 8169.729 | 5755.083 | 7316.864 | 0.746 |
| 3. | 2021 | 13160.565 | 11532.596 | 11685.013 | 9320.179 | 10845.929 | 0.824 |
| 4. | 2022 | 7768.715 | 6160.798 | 6290.959 | 4963.801 | 5805.186 | 0.747 |
| Average | | 10040.731 | 8341.55 | 8493.337 | 6350.227 | 7728.371 | 0.764 |

The SCS-CN approach may be applied as a rainfall-runoff model, according to this debate. Additionally, despite their differences, the SCS-CN approach and the USLE method both take into consideration watershed characteristics. Therefore, it is hypothesized that by combining these two approaches, one can calculate the sediment yield given information about rainfall, soil type, land use, and the moisture content of the antecedent soil [18], [31]. Therefore, the goal of this study is to

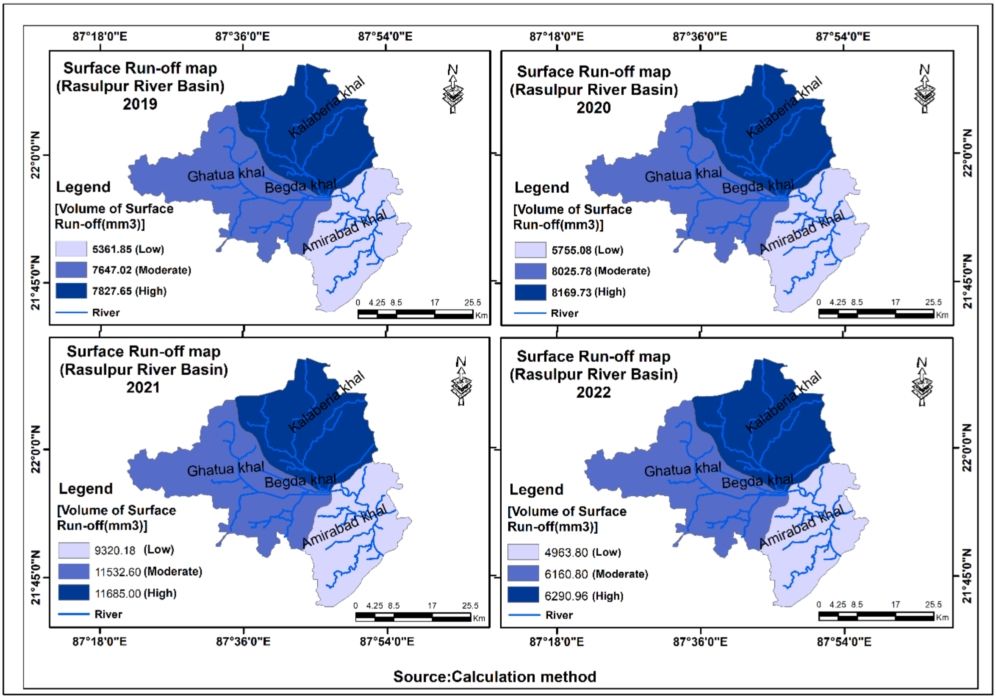


**Figure 9:** *Surface Run-off Map of the Study area.*

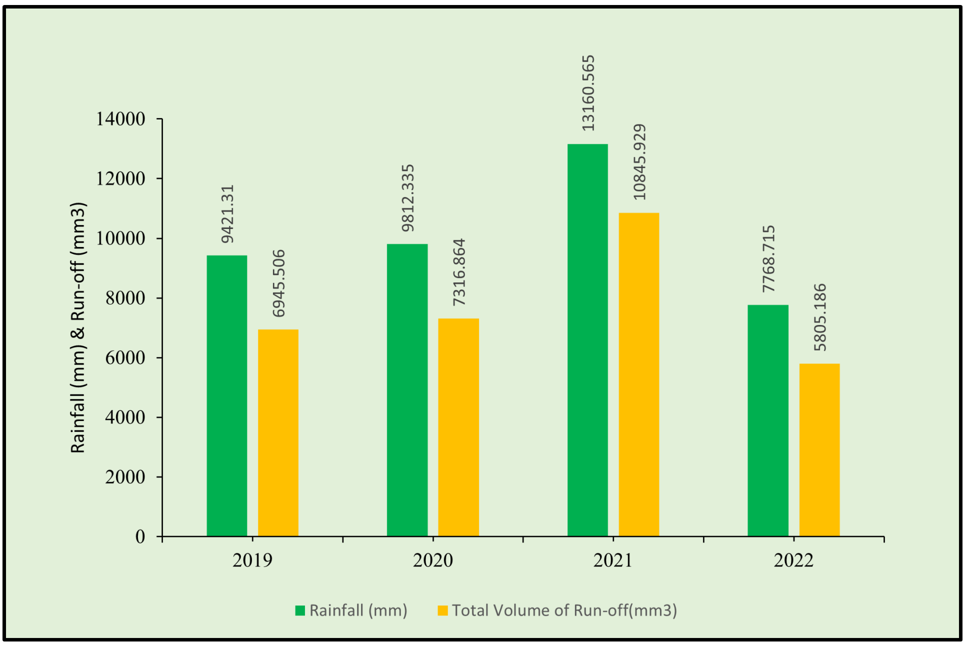


**Figure 10:** *Annual actual Rainfall (mm), volume of Run-off depth* (mm)$^3$, *of the Rasulpur river basin.*

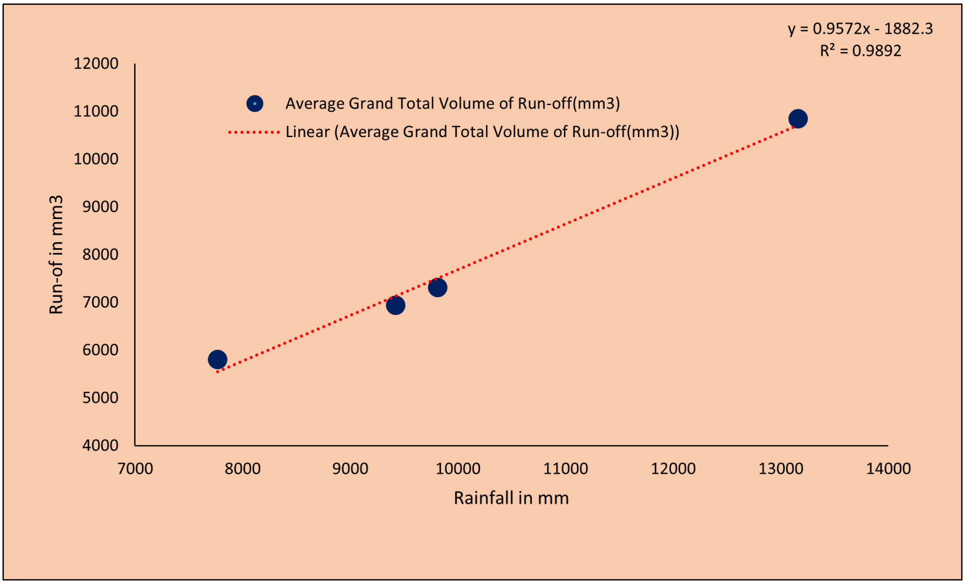


**Figure 11:** *Scatter Plot among the Annual actual Rainfall (mm) and volume of Run-off depth* $(\mathrm{mm})^3$ *of the study.*

construct an analytical model for sediment yield computation by combining the SCS-CN approach with USLE. There are currently no reports of this pairing in the literature. Three conjectures form the basis of the coupling: (1) the runoff coefficient is equal to the saturation degree; (2) the USLE parameters can be used to define the possible maximum retention; and (3) the runoff coefficient is equal to the sediment delivery ratio. A sizable collection of rainfall-runoff-sediment yield data (98 storm events) from 12 watersheds with varying land uses (urban, agricultural, and forest) and sizes ranging from 300 $m^2$ to a few $km^2$ are used to test the proposed sediment yield model [32]. A CN value derived from catchment parameters and antecedent rainfall five days prior to the event is used in the SCS-CN approach to estimate direct event runoff for a known quantity of rainfall. The SCS-CN computed runoff was far more responsive to the selected CN value than it was to the volume of rainfall. Accurately choosing CN values from the body of available information is likewise more difficult [33]. A steady reduction in storm-event CN values with increasing rainfall amounts accounts for one of the significant uncertainties. This is mostly because the temporal variation in rainfall and runoff process has been discounted. [23].

## 6. Limitation and Recommendation

Since our study relies on publicly available Remote Sensing and GIS datasets, which may have limits in terms of coverage, accuracy, and spatio-temporal resolution all researchers have more constraints than others. Limited ground-based data for model calibration and validation could also affect the accuracy of hydrological modelling results. The Soil Conservation Service Curve Number (SCS-CN) method, while widely used for rainfall-runoff modelling, involves several assumptions and simplifications that may not fully capture the complexities of hydrological processes within the Rasulpur River Basin. Variability in land cover, soil properties, and precipitation patterns may not be adequately represented, leading to uncertainties in model predictions. a specific temporal and spatial scale within the Rasulpur River Basin, which may not fully capture the variability and dynamics of hydrological processes at different scales. Future studies could explore multi-scale analyses to better understand the interactions between local and regional hydrological processes. By addressing these issues and considering the new path for research, I can improve our knowledge for advanced modelling, enhanced data integration, and impact assessment of climate change. I also inform sustainable water resource management strategies in the Rasulpur River basin and other similar region across the world.

## 7. Conclusion

The estimation of run-off using the Soil Conservation Service Curve Number (SCS-CN) method, combined with remote sensing and Geographic Information System (GIS) techniques, provides an effective approach for assessing water resources in a given area. By integrating satellite imagery and topographic data into the SCS-CN model, we can accurately determine the CN values for different land cover types, thereby improving the accuracy of run-off estimation. Remote sensing allows for the acquisition of large-scale, high-resolution data, which is crucial for capturing the spatial variability of land cover and its associated hydrological characteristics. In this study, ArcGIS and GEE are combined with LULC data to create a hydrological soil group map. By combining HSG and LULC categories, The Weighted CN is determined using AMC-II. After analysis, correlated yearly among the rainfall and run-off for the years 20199 to 2022 represents the total increased run-off associated with the rainfall. The ungauged watershed exhibits an annual average rainfall of four years, volume runoff and runoff coefficients are 10040.731 mm, 7728.371 $(mm)^3$, and 0.764 mm respectively. In these situations, the approaches of RS and GIS are appropriate for determining run-off and river catchment parameters, including rainfall, soil group, LULC dynamics, etc.

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**Abbreviations**

**AMC:** Antecedent Moisture Condition's
**CHIRPS:** Climate Hazards Group Infrared Precipitation with Station Data
**GIS:** Geographic Information Systems
**GEE:** Google Earth Engine
**LULC:** Land Use Land Cover
**NEH:** National Engineering Handbook
**RS:** Remote Sensing
**SCS:** Soil Conservation Service
**SCS-CN:** Soil Conservation Service-Curve Number.

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