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Original Article

Land Use Change and Soil Conservation Services Curve Number (SCS-CN) in Karangmumus Watershed Samarinda

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Abstract *- Land use changes significantly impact hydrological processes and flood risk. This study investigated land use changes and their effect on the Soil Conservation Services Curve Number (SCS-CN) in the Karangmumus Watershed, Samarinda, Indonesia. Land use data from the Ministry of Environment and Forestry, spanning 1992-2020, revealed a decline in secondary dryland forest area by 26.2 km² and expansion of mining activities by 13.7 km². These changes significantly altered the SCS-CN, increasing from 70.39 in 1992 to 77.48 in 2020. A strong linear relationship between SCS-CN and peak discharge (R^2 = 0.996) was observed, indicating that every unit increase in SCS-CN resulted in a 1,6842 m^3/second increase in peak discharge. This highlights the critical role of land use management in mitigating flood risk in the Karangmumus Watershed. The study emphasizes the need for strategies such as land rehabilitation, afforestation, and effective drainage systems to address the increasing runoff potential and mitigate flood risk in this region.*

Keywords *- Land use, Curve number, Watershed, Karangmumus, Peak discharge.*

1. Introduction

The Karangmumus Watershed is a crucial watershed in Samarinda City, East Kalimantan. This watershed plays a vital role in maintaining ecosystem balance and supporting the livelihood of surrounding communities. However, in recent decades, the Karangmumus Watershed has faced various complex environmental issues, particularly related to significant land use changes. One of the primary issues confronting the Karangmumus Watershed is the conversion of forest land into mining areas. Mining activities, especially coal mining, have become one of the main economic sectors in East Kalimantan. However, the expansion of this sector has resulted in severe environmental degradation, including loss of forest cover and alterations in soil characteristics. The land use change from forests to mining areas has significant impacts on the hydrological properties of the Karangmumus Watershed. The loss of vegetation and changes in soil structure due to mining activities can alter infiltration patterns, surface runoff, and soil erosion. This, in turn, can affect the watershed's hydrological response to rainfall and increase the risk of flooding and sedimentation in downstream areas. In January 2020, the Karangmumus River Basin experienced severe flooding that impacted 12,901 individuals and submerged 20 primary roads with water levels reaching up to 1 meter, thereby disrupting the mobility of residents. A significant issue that has emerged within the community of Samarinda is the conversion of forest land into mining areas, which has been identified as a primary factor contributing to these flooding incidents. Consequently, a comprehensive study is required to examine the effects of land use change on surface runoff coefficients and its implications for discharge in the Karangmumus River Basin. To understand and manage the impacts of land use changes on watershed hydrological characteristics, the Soil Conservation Service Curve Number (SCS-CN) method has been widely employed in various studies. This method provides a relatively simple yet effective approach to estimating surface runoff based on soil characteristics, land cover, and antecedent hydrological conditions. Research on surface runoff coefficients plays a crucial role in flood risk reduction efforts. Due to population growth, climate change, and alterations in land cover, the frequency and intensity of floods are on the rise in various regions worldwide. Therefore, research on surface runoff coefficients, a key parameter in hydrological models, is highly necessary. One of the primary reasons for the importance of this research is to enhance our understanding of how rainfall flows into river systems and urban drainage channels. Surface runoff coefficients influence the extent to which rainfall in each area becomes surface runoff that ultimately reaches rivers and the extent to which the soil absorbs it or infiltrates into urban drainage systems. A deeper understanding of this process enables us to develop more effective strategies for flood risk reduction, including appropriate land cover planning, efficient drainage systems, and improved flood mitigation [1-4]. Furthermore, research on surface runoff coefficients can provide valuable insights into how changes in land cover, including urbanization, deforestation, and other land-cover alterations, can affect surface runoff patterns and the potential for flooding [5]. Thus, this research can serve as a foundation for better decision-making in urban planning and the sustainable management of water resources to reduce flood risks in the future [6].

The Soil Conservation Service Curve Number (SCS-CN) method plays a pivotal role in the management and mitigation of rainfall-runoff impacts across various landscapes [7]. The CN method is widely employed in the fields of hydrology and water resource management to estimate direct runoff resulting from rainfall events. One of its primary advantages lies in its simplicity and practicality, rendering it accessible to a wide range of users, including engineers and land planners. The CN method is based on the classification of land cover, soil type, and hydrological soil groups, making it relatively straightforward to apply in diverse geographical and environmental settings. Nonetheless, the CN method comes with its limitations. One of its shortcomings is its assumption of a constant CN value for a specific land cover or land use category, which may not always accurately represent real conditions in the field [8]. This simplification can lead to inaccuracies in estimating runoff, especially in regions with heterogeneous land use and variable soil conditions. Furthermore, the CN method does not account for factors such as antecedent soil moisture conditions, changes in vegetation cover, or land management practices, which can significantly influence the runoff process. Therefore, while the CN method offers a practical approach to runoff estimation, it may not provide the level of precision required for certain applications, particularly in areas with complex land use patterns and varying soil characteristics. Overall, the Soil Conservation Service Curve Number (SCS-CN) method serves as a valuable tool in the estimation of direct runoff within the fields of hydrology and soil conservation. Its simplicity and ease of use facilitate its application in various contexts, but users should be cognizant of its limitations, particularly in addressing heterogeneity in land cover and variable soil characteristics. Refinements and adjustments of the CN method considering local factors can be a critical step in reducing uncertainty in runoff estimation and enhancing sustainable water resource management. The research on land use changes and the utilization of the Soil Conservation Service Curve Number (SCS-CN) method forms a critical foundation for flood risk reduction and efficient water resource management [9]. As floods increasingly pose substantial social, economic, and environmental threats due to factors like population growth and climate change, the assessment of surface runoff coefficients, a key parameter in hydrological models, becomes imperative. Understanding how rainfall transforms into runoff and infiltrates the urban landscape is essential for developing effective flood risk mitigation strategies. Moreover, the influence of land use alterations, such as urbanization and deforestation, on surface runoff patterns and flood potential highlights the necessity for research in the realms of urban planning and sustainable water resource management. Given the condition of the Karangmumus watershed, which has experienced significant land use changes from forest to mining areas, it is considered important to study the impact of these land use changes on the surface runoff coefficient in the watershed. The Soil Conservation Service Curve Number (SCS-CN) method is one approach that can be used to examine this issue. This research primarily aims to assess how land use patterns and the Soil Conservation Service Curve Number have changed in the Karangmumus Watershed for the years 1992, 2000, 2010, and 2020, as well as their impact on the discharge rates in the Karangmumus watershed.

2. Study Area

This research was conducted in the Karangmumus Watershed. The watershed boundaries were established using the National Digital Elevation Model (DEMNAS) data with a spatial resolution of 8.3 meters, which was processed using Geographic Information System (GIS) software. The delineation of watershed boundaries involved several steps, including filling data to address pixels with missing elevation values, followed by flow direction, flow accumulation, and automatic watershed boundary delineation using ArcGIS software. The watershed boundaries were then subdivided into several sub-watersheds. The maps of watershed boundaries and the characteristics of each sub-watershed can be found in Figure 1 and Table 1, serving as the primary reference for this research.

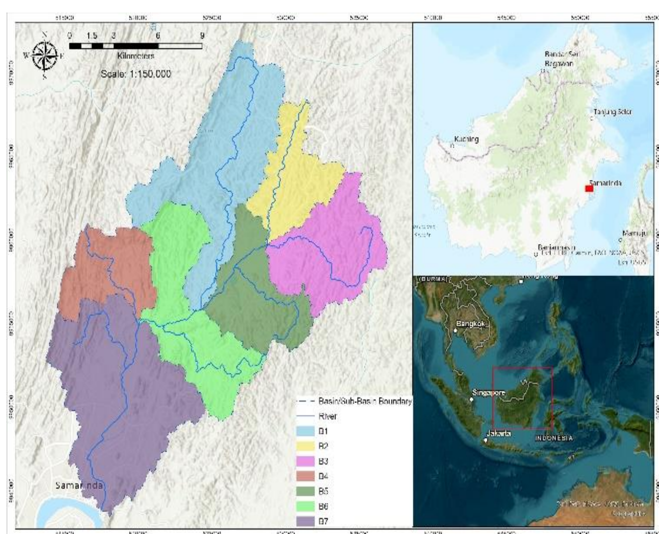

Fig. 1 Research location

Table 1. Watershed characteristics

Sub Bansin	Longest Flowpath Length (Km)	Longest Flowpath Slope	Drainage Density (Km/ Km^2)	Basin Area (Km^2)
B3	15.23	0.00696	0.10772	39.54
B2	12.30	0.00577	0.03609	26.97
B1	24.36	0.008	0.20402	65.57
B5	14.58	0.0092	0.21485	33.44
B6	15.75	0.00719	0.11447	46.85
B4	10.97	0.01996	0.01458	26.17
B7	20.73	0.00619	0.18481	80.36

3. Materials and Methods

3.1. Land Use Data

The land use data used in this research is derived from the Ministry of Environment and Forestry of the Republic of Indonesia, with a scale of 1:250,000 for the period from 1992 to 2020. This dataset provides information on land use changes over nearly three decades, enabling researchers to examine the evolution of land use patterns in the Karangmumus Watershed with an adequate level of resolution. With this data, the research can offer in-depth insights into land use change and its potential to influence Soil Conservation Service Curve Number (SCS-CN) parameters in the study area. This data serves as a crucial foundation for land use change analysis and CN calculations for flood risk assessment and water resource management. Land use map 1992, 2000, 2010, and 2020. is depicted in the following Figure 2.

3.2. Soil Conservation Services Curve Number (SCS-CN)

Soil Conservation Service Curve Number (SCS-CN) is a fundamental parameter in hydrology and land management, utilized to estimate direct runoff from precipitation events [10]. It plays a crucial role in assessing the potential for surface runoff and flood risk, particularly in urban and agricultural areas [11].

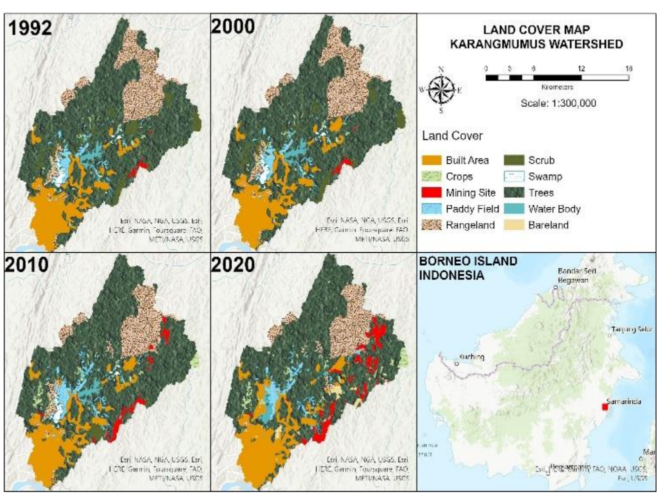

Fig. 2 Land use map in Karangmumus watershed

CN values are determined based on land use, soil type, and hydrological soil group. They are used in rainfall-runoff models to calculate the volume of runoff generated during a rain event [12-15]. This essential tool enables the assessment of the effectiveness of land management practices and the potential impact of land use changes on the hydrological cycle, thereby contributing to more informed decision-making in sustainable water resource management and flood risk reduction strategies [16-19].

The Soil Conservation Service Curve Number (SCS-CN) relies on the consideration of several critical parameters to estimate runoff potential effectively. These parameters encompass land use or land use, soil type, and hydrological soil group (Table 2). Pasture, grassland, or range - continuous forage for grazing" refers to an area of land used as a meadow or greenery where forage, either naturally grown or intentionally cultivated, serves the purpose of providing sustenance for livestock maintenance, particularly for grazing animals such as cattle or goats. In Indonesia, the land use type that aligns with this definition is the utilization of grasslands or meadows for livestock farming. This practice is commonly found in rural and peri-urban areas throughout Indonesia. The "Mixture of brush, weeds, and grass with brush" refers to a combination of vegetation that includes various plants such as brush, weeds, and grass, with brush being the dominant element. This type of vegetation typically exhibits varying thickness and density. In Indonesia, the land use type that aligns with this description is often found in rural and peri-urban areas where the land is not intensively managed and is left to grow naturally. Examples of such land use include rural areas that are not intensively cultivated, open land that remains uncultivated, or regions with a mixture of brush, weeds, and wild grasses. These conditions are frequently encountered in various regions in Indonesia, especially in rural areas that have not undergone significant land use changes.

Table 2. Soil conservation service curve-number

Land Use	Hydrologic Condition	Curve Number for Hydrologic Soil Group			
		A	B	C	D
Pasture, grassland, or range-continues forage for grazing	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Grassland	-	30	58	71	78
Brush-brush weed-grass mixture with Brush is the major element	Poor	48	67	77	83
	Fair	35	56	70	79
	Good	30	48	65	77
Woods-grass combination	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77

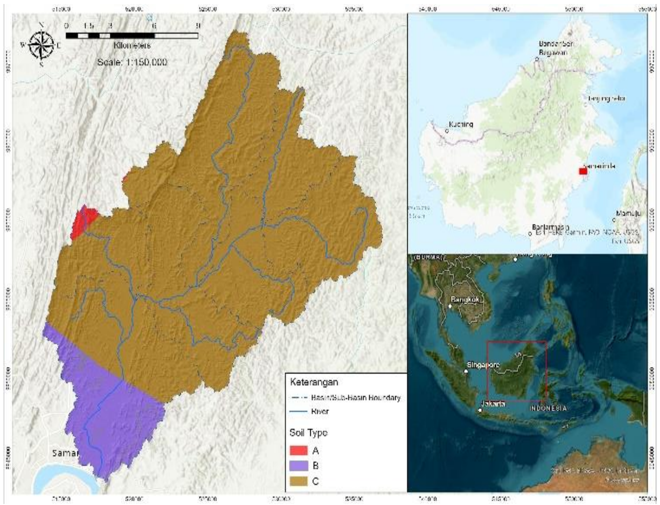

Fig. 3 Soil type of karangmumus watershed

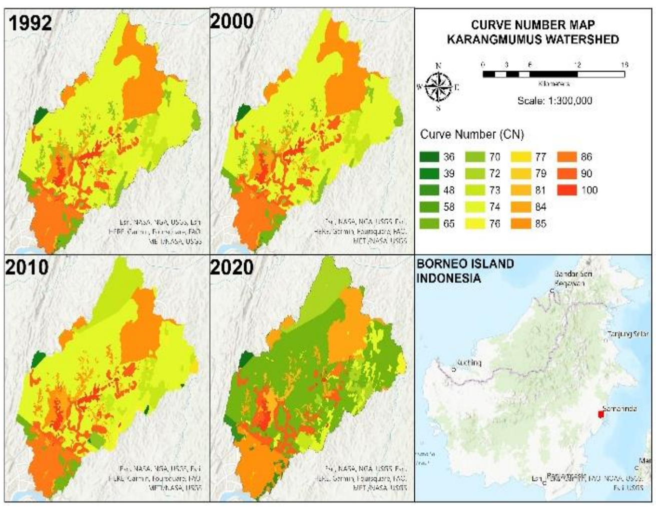

Fig. 4 Soil conservation services curve-number map

The term "Woods-grass combination" refers to a land composition that encompasses forest vegetation or wooded areas intermixed with grass vegetation. It represents a land use type where forests or trees coexist with grasslands or wild grasses. Typically, there is a portion of the forest comprised of densely growing trees, and interspersed among these trees are lower-lying grass plants. In Indonesia, the land use type corresponding to the "woods-grass combination" can be found in various regions with forest or tree vegetation, particularly in rural or peri-urban areas. For instance, land surrounding tropical rainforests or wooded areas that have relatively dense tree growth with a forest floor inhabited by grass plants. This type of land use can be observed on various islands in Indonesia, especially in areas characterized by forests and associated agricultural land. While the term "Woods" refers to forest area. The attached image shows the map of soil types and SCS Curve Numbers for the DAS Karangmumus. The soil type map of the Karangmumus watershed reveals three distinct types: A, B, and C. Type A soil exhibits low runoff potential and a high infiltration rate. It primarily comprises deep sand with minimal silt and clay content, along with highly water-permeable gravel. Geographically, Type A soil is limited to small areas on the western side of the watershed. Type B soil exhibits moderately low runoff potential and a moderate infiltration rate. It consists primarily of sandy soils with a moderate capacity for water percolation. Type B soil is distributed throughout the downstream areas of the watershed. In contrast, Type C soil exhibits moderately high runoff potential and a slow infiltration rate when fully saturated. This type is composed of soils ranging from medium to fine grains (clay and colloids) with a slow water percolation ability. Type C soil is predominantly distributed in the central and upper regions of the watershed.

3.3. Runoff Calculation

The SCS-CN method for calculating runoff is described in the following equation.

$$Pe = \frac{(P - Ia)^2}{P - Ia + S} \qquad (1)$$

Where Pe is the effective rainfall accumulation at time t, P is the total rainfall accumulation at time t, Ia is the initial abstraction. S is the potential maximum storage. The relationship between Ia and S is expressed as:

$$Ia = 0.2 \text{ x } S \qquad (2)$$

The calculation of effective rainfall accumulation is:

$$Pe = \frac{(P - 0{,}2S)^2}{P + 0{,}8S} \qquad (3)$$

The relationship between potential maximum storage (S) and the CN value is:

$$S = \frac{25400}{CN} - 254 \text{ (mm)} \qquad (4)$$

The peak discharge (Qp) and peak time (Tp) are calculated using:

$$Qp = C\,\frac{A}{Tp} \qquad (5)$$

A is the watershed area, C is the conversion factor, and Tp is the peak time. The peak time is calculated using:

$$Tp = \frac{\Delta t}{2} + Tlag \qquad (6)$$

Δt is the duration of rainfall events (hours), and Tlag is the time lag (hours), representing the time taken for rainfall to become surface runoff. The time lag is calculated as follows:

$$Tlag = \frac{L^{0,8} \text{ x } (S+1)^{0,7}}{1900 \text{ x } Y^{0,5}} \qquad (7)$$

L is the main river length (feet), Y is the watershed slope (%), and S is the potential maximum retention (inch). The Transform method, specifically the ModClark method, represents two key processes in transforming rainfall into runoff. These processes are translation, which involves the movement of water from its origin through channels to the watershed outlet, and damping, which reduces the volume of discharge as excess water is retained within the watershed. The equation used is:

$$T_c = 2.2 * \left(\frac{L * L_C}{\sqrt{Slope_{10-85}}}\right)^{0.3} \quad (8)$$

$$\frac{R}{R + T_c} = 0.65 \quad (9)$$

T_c is the Time Concentration (hours), L is the longest flow Path (miles), LC is the Centroid of the flow path (miles), slope 10-85 is the average slope of the longest flow path (ft/ mile), and R is the storage coefficient. To determine the peak discharge in the Karangmumus River Basin, rainfall data is essential. The rainfall data utilized in this study consists of daily precipitation for January 2020 obtained from the Meteorology, Climatology, and Geophysics Agency. January was selected based on the timing of the flooding events in the Karangmumus River Basin in Samarinda. Meanwhile, the peak discharge is calculated using the values of surface runoff coefficients based on land use from the years 1992, 2000, 2010, and 2020. The rainfall data for January 2020 is presented in Table 3.

4.Results and Discussion

4.1. Land Use Change

In the context of the Karangmumus Watershed (DAS Karangmumus), the identification of specific aspects of land use is highly relevant for understanding surface runoff coefficients and flood mitigation efforts. Firstly, it is crucial to identify the types of land use in this area, including the extent to which land has been converted into urban areas, agricultural fields, or forested regions. This is significant because various land uses exhibit different characteristics regarding their ability to absorb rainfall and generate surface runoff.

Table 3. Rainfall data for January 2020

Date	Rainfall (mm/day)	Date	Rainfall (mm/day)
1	0	17	5.5
2	9.5	18	33
3	53	19	6
4	2	20	0
5	0	21	40.12
6	0	22	20.5
7	0	23	0
8	0	24	0
9	9.8	25	10.2
10	108.6	26	10.7
11	101.5	27	42.4
12	49	28	0
13	3.4	29	0
14	91.3	30	52
15	0	31	29.2
16	0		

Source: Meteorology, Climatology, and Geophysics Agency

Table 4. Land use area 1992, 2000, 2010 and 2020

Land Use	Area (Km^2)				Land Use Change (Km^2)
	1992	2000	2010	2020	
Airport	0.1	0.1	0.1	2.3	2.2
Secondary Dryland forest	182.1	182.1	161.4	155.8	-26.1
Plantation forest	11.8	11.8	40.15	14.47	2.6
Residential area	41.8	43.6	43.47	53.59	11.7
Food Estate	0.2	0.2	2.39	2.88	2.6
Mining	1.3	1.3	6.38	15.13	13.7
Dryland agriculture	2.2	2.2	3.84	3.45	1.2
Dryland agriculture with shrubs	49.3	49.4	42.15	52.52	3.2
Swamp	3.5	3.5	3.56	3.33	-0.23
Paddy field	6.6	6.6	9.34	9.09	2.48
Scrubland	16.5	14.5	2.8	2.9	-13.46
Waterbody	3.1	3.1	3.23	3.2	0.11

Furthermore, it is also important to identify the condition of vegetation and tree cover in the Karangmumus Watershed. Deforestation or changes in land use patterns can affect the ability of forests or vegetation to absorb rainfall and reduce surface runoff. Identifying these changes can be a critical factor in determining the SCS-CN (Soil Conservation Service Curve Number) values for the area. By identifying these aspects, we can develop a more holistic understanding of the relationship between land use, surface runoff coefficients, and flood mitigation in the Karangmumus Watershed. This will serve as a strong foundation for effective planning to reduce flood risk in the region. The land use data is then matched with the land use classification in the Soil Conservation Service Curve Number. The table below displays the land use changes from 1992, 2000, 2010, and 2020.

The reduction around the Secondary Dryland Forest in the Karangmumus Watershed by 26.2 km² from 1992 to 2020 is a significant change with important implications for the surface runoff coefficient. Secondary dryland forests play a vital role in regulating surface runoff and rainwater infiltration. The reduction in forest area has the potential to increase surface runoff due to the loss of efficient vegetation cover for water absorption. This can lead to increased runoff, contributing to the potential for flooding and greater soil erosion. Moreover, the reduction in forest cover can also influence the SCS-CN (Soil Conservation Service Curve Number) values for the region, given the changes in land use. Therefore, it is crucial to consider restoration or conservation efforts for secondary dryland forests as part of a mitigation strategy to reduce flood risk and maintain ecosystem balance in the Karangmumus Watershed. The increase in mining area by 13.7 km² in the Karangmumus Watershed has significant implications, particularly in the context of the Soil Conservation Service Curve Number (SCS-CN) and the potential for flooding.

Mining often brings about substantial changes in land structure, involving the removal of natural vegetation and topsoil layers. This can result in significant alterations in the CN for the area, with higher CN values due to the loss of the soil's ability to infiltrate rainfall. The elevated CN values can lead to increased surface runoff and a higher potential for flooding, especially in the absence of efficient drainage systems. Therefore, it is crucial to consider appropriate management measures in mining areas, including mitigation steps like re-vegetation and careful land use planning to reduce its impact on surface runoff coefficients and the flood risk in the Karangmumus Watershed.

In summary, the changes in land use within the Karangmumus Watershed, including the reduction in secondary dryland forest and the expansion of mining areas, have substantial implications for the Soil Conservation Service Curve Number (SCS-CN) and, by extension, the potential for flooding. The reduction in secondary dryland forest, a crucial element in controlling surface runoff and rainwater absorption, may lead to increased surface runoff and elevated flood risks. On the other hand, the expansion of mining areas can result in higher CN values, which contribute to greater surface runoff and a heightened risk of flooding. Both changes underscore the importance of proactive land management and mitigation strategies to maintain the balance between surface runoff coefficients and flood risk reduction within the Karangmumus Watershed.

4.2. SCS-CN Karangmumus Watershed

In the realm of watershed management, understanding the distribution of Curve Number coefficients holds paramount significance, as it plays a crucial role in assessing runoff potential and hydrological processes. The Karangmumus watershed serves as the focal point of this investigation, where an in-depth mapping of Curve Number coefficients is undertaken. This preliminary exploration aims to unravel the intricate nuances of hydrological behavior within the watershed, paving the way for informed decision-making and sustainable water resource management strategies. As we delve into the outcomes of the mapping exercise, a comprehensive comprehension of the spatial variability of Curve Number coefficients in the Karangmumus watershed will emerge, contributing valuable insights to the broader field of hydrological research and watershed management.

The graph illustrating the variation in Soil Conservation Service Curve Number values within the Karangmumus Watershed from 1992 to 2020 is presented in Figure 5. This visual representation serves as a key tool for examining patterns, trends, and fluctuations in the hydrological characteristics of the watershed over this nearly three-decade period. The analysis of this graph aims to provide a comprehensive understanding of the dynamic changes in Soil Conservation Service Curve Numbers, offering valuable insights into the watershed's hydrological dynamics and the potential implications for soil conservation measures. Based on the graphical analysis, it is evident that there has been an increase in the Soil Conservation Service Curve Number (SCS-CN) values in the Karangmumus Watershed during the period from 1992 to 2020. In 1992, the CN value was recorded at 70.39, and by the year 2000, it had risen to 74.52.

Subsequently, in 2010, a further increase was observed, reaching 75.57, and in 2020, the CN value peaked at 77.48. This gradual escalation may reflect changes in hydrological conditions and land management practices within the Karangmumus Watershed over the observed period. Factors such as alterations in land cover, land use, and soil conservation policies could contribute to this dynamic. Further analysis is required to understand the implications of these increased CN values on runoff potential and soil conservation efforts in the region.

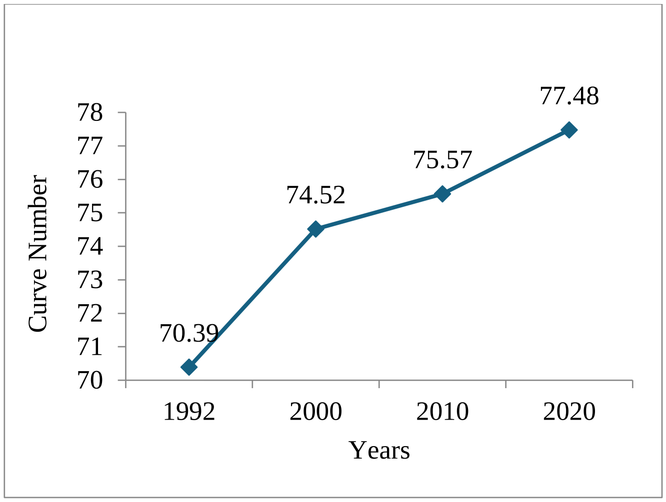

Fig. 5 SCS-CN value 1992 to 2020

Observing the available data, it is evident that there has been a significant increase of 7.09 or 9.15% in the Curve Number value in the Karangmumus Watershed from 1992 to 2020. This increase raises concerns about the potential for flooding in the Karangmumus Watershed. The increase in the Curve Number value can reflect an increase in the potential for surface runoff and runoff, which in turn can increase the risk of flooding in the area. Factors such as land use change, urbanization, or changes in rainfall patterns can be major contributors to this change. Further analysis is needed to understand the relationship between the increase in the Curve Number value and the potential risk of flooding, as well as to design effective water management strategies to address this challenge.

4.3. Surface Runoff

Surface runoff in this study is calculated using rainfall data for January 2020, specifically based on the flooding event that occurred on January 11, 2020. The surface runoff, or peak discharge, generated in the Karangmumus River Basin is determined using watershed characteristic data, precipitation data, and surface runoff coefficient values, employing the Soil Conservation Service Curve Number (SCS-CN) method. The results of these calculations are presented in Table 5. Hydrological component calculations within the Karangmumus watershed demonstrate a complex and interconnected pattern of change. An increase in the Curve Number (CN) signifies a heightened potential for runoff volume driven by deforestation, urbanization, and land degradation within the watershed.

This increase negatively impacts the watershed's water storage capacity, as evidenced by the declining Storage Coefficient (S). The table simultaneously reveals a reduction in the Storage Coefficient, a measure of the watershed's ability to retain water, attributed to changes in vegetation cover within the Karangmumus watershed. Despite the amplified runoff, the peak discharge shows only a slight increase. The most significant increase occurred between 1992 and 2000, with a 7.5 m3/second rise in discharge. While this increase may appear insignificant, it remains a crucial concern for policymakers, highlighting the need for maintaining or enhancing the drainage capacity of the Karangmumus River as a critical mitigation measure for reducing flood risk in the Karangmumus watershed of Samarinda City. Furthermore, based on the calculations in Table 5, we can observe a relationship between the Soil Conservation Service Curve Number of the Karangmumus watershed and the discharge.

This relationship can be visualized in the following graph. The graph demonstrates a strong linear relationship between the SCS CN (Surface Runoff Coefficient) and peak discharge (Qp) in the Karangmumus watershed. The regression equation obtained is y = 1.6842x + 245.84 with an R^2 value of 0.996. An R^2 value close to 1 indicates a very high correlation between the SCS CN and peak discharge, implying that changes in the SCS CN will significantly impact changes in peak discharge in the Karangmumus watershed. This suggests that an increase in the SCS CN in the Karangmumus watershed will lead to an increase in peak discharge. The graph reveals that an increase in the SCS CN value by 1 unit results in an increase in peak discharge by 1,6842 m^3/second. This signifies that the relationship between the SCS CN and peak discharge is quite sensitive. Small changes in the SCS CN can significantly impact the peak discharge. Therefore, flood mitigation efforts in the Karangmumus watershed should focus on controlling the SCS CN value.

Table 5. Runoff calculation results

Hydrologic Component	Year of Land Use			
	1992	**2000**	**2010**	**2020**
CN	70.39	74.52	75.57	77.48
S	106.85	86.85	82.11	73.83
Ia	21.37	17.37	16.42	14.77
Qp (m^3/s)	364.20	371.70	373.30	376.00

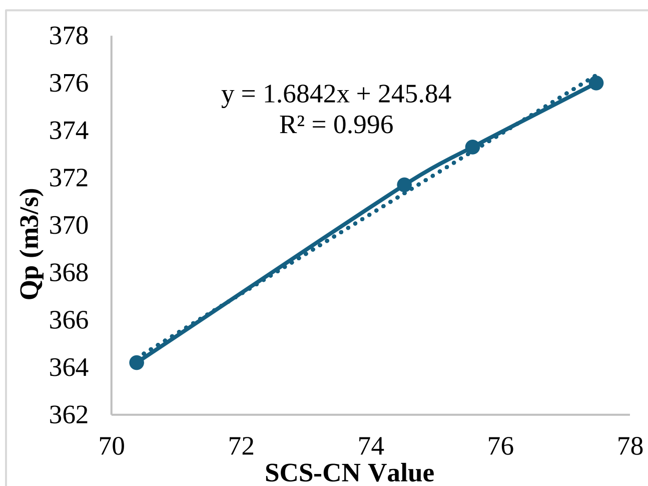

Fig. 6 Relationship between SCS CN and Peak Discharge (Qp)

Controlling the SCS CN value can be achieved through various measures such as land rehabilitation, afforestation, and rainfall management to reduce the SCS CN value and prevent an increase in peak discharge. The graph demonstrates that the SCS CN value has a strong influence on peak discharge in the Karangmumus watershed. Factors affecting the SCS CN value, such as land cover changes, soil conditions, and rainfall patterns, are crucial for flood management in the Karangmumus watershed. This graph can serve as a basis for developing more effective flood management strategies in the region.

5. Conclusion

This study identified significant land use changes in the Karangmumus Watershed from 1992 to 2020, with crucial implications for surface runoff coefficients and flood mitigation. Notably, the decline in secondary dryland forest area by 26.2 km² and the expansion of mining activities by 13.7 km² pose considerable challenges. Loss of natural vegetation reduces soil infiltration capacity, leading to increased surface runoff and heightened flood risks. Additionally, mining alters the land structure and elevates CN values, further exacerbating surface runoff and potential flooding. To address these concerns, comprehensive land management strategies are essential. Restoring and conserving secondary dryland forests, implementing effective drainage systems in mining areas, and employing proper land use planning are crucial steps to maintain a sustainable balance between surface runoff coefficients and flood mitigation efforts in the Karangmumus Watershed. An in-depth mapping of Soil Conservation Service Curve Number (SCS-CN) coefficients in the Karangmumus Watershed revealed a worrisome trend of increasing runoff potential over the period 1992-2020. The CN value climbed steadily from 70.39 in 1992 to 77.48 in 2020, representing a significant increase of 7.09 or 9.15%. This suggests a heightened risk of surface runoff and flooding within the watershed. While further analysis is required to pinpoint the specific drivers of this rise, potentially influencing factors include changes in land cover, land use practices, and soil conservation policies. These findings underscore the urgent need for comprehensive land management strategies that prioritize runoff mitigation and sustainable water resource management in the Karangmumus Watershed. By addressing the challenges posed by elevated CN values, we can safeguard soil conservation and reduce the risk of catastrophic flooding in this vulnerable region.

An increase in the surface runoff coefficient directly corresponds to an increase in surface runoff volume. Research conducted in the Karangmumus watershed reveals a significant correlation between the Soil Conservation Service Curve Number (SCS-CN) and peak discharge. Notably, every unit increment in the SCS-CN value within the watershed leads to a 1,6842 m^3/second rise in peak discharge. This underscores the sensitive nature of the relationship between the SCS-CN and runoff, emphasizing the significant impact even minor changes in the SCS-CN can have on the volume of surface runoff generated.

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