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Research Article

ESTIMATION OF SOIL EROSION CAUSED BY SURFACE RUNOFF USING DAS OPERATING TECHNIQUE IN BUNDELKHAND REGION

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Abstract: Agriculture is an important part of India's economy and at present it is among the top farm produces in the world. This sector provides approximately 52 percent of the total number of jobs available in India and contributes around 17-18 percent to the GDP. For maximum growth of food production, nutritional soil and water plays a vital role. But due to soil texture and its structure erosion is a major problem which reduced the soil nutrient and its fertile property. An area of over 80 million hectares or about one-fourth of total area is exposed to wind and water erosion out of which 40 million hectares of land has undergone serious erosion. The loss due to water erosion is 53.34 million hectares annually (ICAR). The present work has attempts to emanate the runoff and soil erosion based on DAS technique for controlling the erosion and its treatment for enhancing crop production and availability the ground water recharge for livelihood and other ecosystem activities.

Keywords: *Rainfall, Runoff, DAS system, Pressures (Water and Atmospheric) and Soil erosion*

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Introduction

Runoff and soil erosion are important hydrological parameters for any area as they give information about the amount of water available at the outlet of a catchment, storage potential of the area, amount of eroded soil [1]. Globally, 1964.4 M ha of land is affected by human-induced degradation [2]. Of this, 1,903 M ha are subjected to aggravated soil erosion by water and another 548.3 M ha by wind. The major importance of this study is to control soil erosion and enhance the water availability by infiltration and deep percolation which is convert in the form of baseflow. For surface and ground water management, creation of remote sensing and GIS based inventories on land degradation, development of indigenous sensor based instruments for monitoring hydrological parameters, studies on climate change impact on soil and water resources, refinement of soil and moisture conservation and water harvesting structures to mitigate the climate change impacts and participatory water resources management conserving the soil and water resources [3].

Material and Methods

Study Area

The analysis of this experiment has taken in Jhansi district of Uttar Pradesh state. It is located between 25°26' 55"N latitude 78°34' 11" E longitude and. The total area of experiment al place is 5024 km2 but analytical area has been selected only 300 m^2 (0.03 ha). The elevation varies from 270 to 315 m above mean sea level (MSL).

Agro-climatic Characterization of Study Area

The agro-climate of the study area is characterized by dry and hot summer, warm and moist rainy season and cool winter with occasional rain showers. Average summer temperature and average winter temperature is 47°C (117°F) and 4.0°C (39.2°F) respectively. The annual rainfall of the Bundelkhand region varies from 800 to 1300 mm, about 90% of which is received during South-West monsoon period [4]. Long term weather data monitored at Jhansi station (nearby site) shows that annual average rainfall in study region is 877 mm with about 85 % falling from June to September. The numbers of rainy days during the monsoon and non-monsoon period are 42 and 13, on average, respectively. It has been observed that in a cycle of 5 years, 2 are normal, 2 drought years and 1 is excessive rainfall year [5]. Further, with the analysis of fifty years (1946-1995) rainfall data of Jhansi it was observed that 18 % of the years were drought, 68% normal and 14% were surplus years, implying that there is likelihood of one drought year in 5 years span [6].

Geology

The geology of the study area is dominated by hard rocks of Archaen granite and gneiss and largely composed of crystalline igneous and metamorphic rocks [7], and aquifers are either unconfined or perched, having poor storage capacity (porosity of 0.01-0.05 %). These aquifers were derived primarily from weathering and developed into two layered system: i) unconsolidated fractured layers derived through prolonged weathering of bedrocks within 10-15 m depending upon the topography, drainage and vegetation cover; ii) relatively impermeable basement starting from 15-20 m depth [8]. In such hard rock aquifers with poor transmissibility, shallow dug wells of 5 to 15 m depth are only primary source of water for domestic and agricultural use in this region.

Crop and Cropping Sequences

Due to undulated topography, poor groundwater potential, high temperature, poor and erratic rainfall, agricultural productivity in this region is very poor (0.5-1.5t ha^{-1}).

Table-1 *Water head and corresponding values of Runoff and Soil erosion from July to September*

SN	Events Time	Pr. (Water+Baro)	Pr. (Baro)	Head (m)	Event Rainfall (mm)	Average Rainfall (mm)	Total runoff (mm)	Runoff in %	Soil Erosion (gm)
1	19-Jul	77974.58	77290.6	683.98	50.8	1120	25.84	50.88	23262
2	23-Jul	37964.41	37568.68	395.73	42.2	1120	11.28	24.95	10152
3	24-Jul	30033.46	29693.28	340.18	43.4	1120	15.7	36.17	14130
4	25-Jul	29035.66	28721.28	314.38	67.2	1120	11.37	16.92	10236
5	24-Aug	36204.53	35748.35	456.182	68.9	1120	26.87	38.99	24183
6	29-Aug	35289.51	34822.53	466.985	48.4	1120	33.17	68.55	29859
7	01-Sep	56471	55704.33	766.673	83.6	1120	34.05	40.73	30648
8	02-Sep	67570.45	66702.7	867.748	114.3	1120	56.38	23.17	50748
9	08-Sep	91499.57	90392.57	1106.993	142.3	1120	93.65	65.81	84288

The length of growing season in Bundelkhand ranges between 90 to 150 days depending upon rainfall and temperature regimes. Low rainfall and drought are common features. Long dry spells during rainy season are also experienced often, which adversely affect the crops. The agriculture involves the cultivation of cereals, pulses and oilseeds and some vegetables. Groundnut is the major crop in both villages in kharif season. Black gram, green gram, sesamum are other crops of kharif season. Wheat is the major crop during *rabi* season, which is mostly supplemental irrigated, depending on availability of water in open wells.

Soils

The soils of the study area can be conveniently grouped into major soil groups *viz*., red soils and (ii) black soils. The red soils are coarse grained upland soils while black soils are heavy soils. These soils are further classified according to their texture and color into four distinct series namely Rakar and Parwa in red soils and Kabar and Mar in black soils. The type 1A Rakar soils are the soils of rocky ridges and are not important agriculturally. The other type I B is shallow (10-50 cm), reddish to brownish red in color having immature profile development (Alfisols and Entisols) which is characterized by coarse gravelly and light textured with poor water holding capacity.

Table-1 *Water head and corresponding values of Runoff and Soil erosion from July to September*

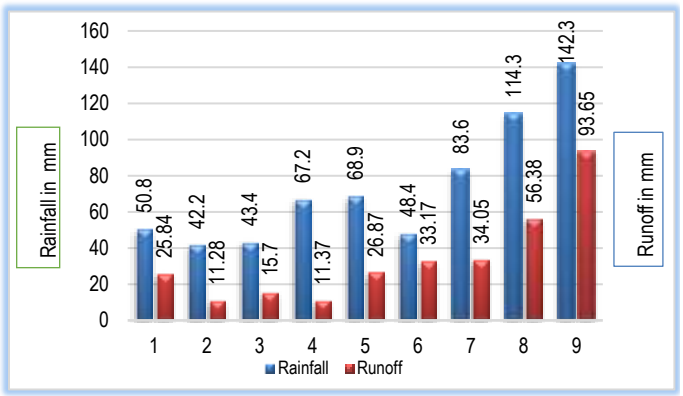

Fig-1 Rainfall-Runoff Relationship

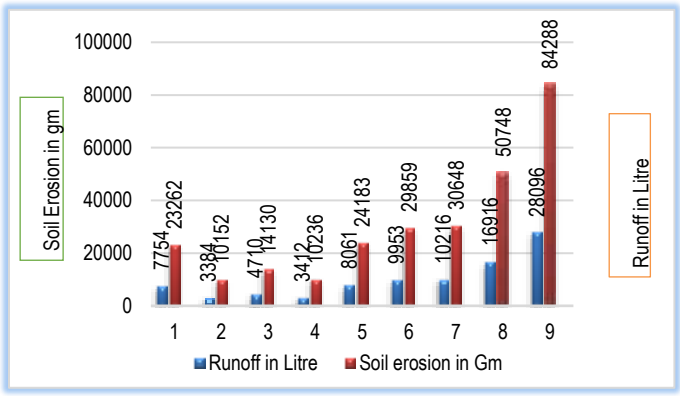

Fig-2 Runoff-Soil Erosion Relationship

V-Notch

A V-notch or 90° notch is constructed as standard dimensions used for runoff estimation in selected area. The runoff or discharge is estimated by following formula,

$$Q = 1.417*H^{5/2}$$

Where, Q = Runoff or discharge in m^3/sec, H = Water Head in m

Result and Discussion

Soil erosion is a major problem which mostly eroded by action of water. There are various heads are predicted at various rainfall events, but it was observed that maximum head occurred in 8 Sep 2018 while minimum in 25 July 1106.99 cm and 314.38 cm respectively [Table-1]. There are various rainfall events in corresponding value of annual average rainfall is 1120 mm. The peak runoff at rising limb (Highest) is 93.65 mm while at falling limb (lowest) 11.28 mm [Fig-1]. The maximum soil erosion is 84288 gm occurs at 8 September 2018 while minimum 10152 gm at 23 July 2018 [Fig-2]. At above cited it is required to maintain the fertility of soil, various treatment and NRM adopted for control of soil erosion and pollution of our ecosystem.

Conclusion

The present study utilized DAS and V-Notch to estimate an empirical correlation between rainfall-runoff and runoff-soil erosion for study area. The estimated result is shows that treatment is required to control runoff and soil erosion at different stages.

Application of research: The research will be helpful for study the rainfall which converts in the form of runoff and effects the soil fertility. It will be also helpful for study of various treatment to control soil erosion and enhancing crop growth and ground water recharge.

Research Category: DAS technique

Abbreviations: Mha:Million hectare; MSL:Mean sea level; gm;Gram; mm:Millimetre; cm:Centimetre; m:Metre; m^3/sec:Cubic metre per second

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Study area / Sample Collection: Bundelkhand region, Jhansi, U.P., India

Cultivar / Variety name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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