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Impact of Two Natural Rainfall Events in Erosion of Soil, Water and Nutrients in a Wasteland Area of Bundelkhand Region (U.P.) India

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***Abstract*— Present investigation has been carried out at two selected sites (I & II) in a wasteland area of Orai (Jalaun), Uttar Pradesh to see the impact of erosion on soil, water and nutrients in two natural rainfall events i.e. 14 and 11 mm on two different days during rainy season. The vegetated plot showed lower values of soil erosion, run-off water and nutrient loss and high infiltration rate in comparison to bare plot at both the sites (I & II). It was observed that the loss of soil, water and nutrients (N and P) were more at site I in comparison to site II. The annual soil loss in total rainfall (1146.6 mm) of the year during study period (2016) was 2.01 t/ha/yr in vegetated and 24.86 t/ha/yr in bare plots at site I. In contrast, values were 1.74 t/ha/yr in vegetated and 23.73 t/ha/yr in bare plots at site II.**

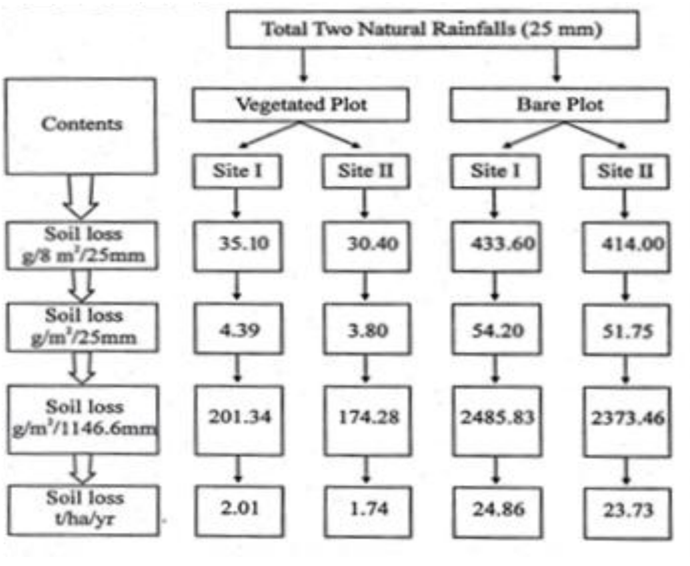
Keywords: Erosion, Run-off , Rainfall

I INTRODUCTION

In Bundelkhand region wasteland is more or less fragile and delicately balanced. The vegetation of present study sites (I & II) are not very rich in plant diversity. In recent years due to increase in anthropogenic activities, the quality of soil on such land has suffered enormously by erosion. Therefore, it has attracted the attention of ecologists to explore the habitat with the problem of erosion. Eroded sediments are generally composed of aggregates and primary particles with different size or settling velocity characteristics (Meyer *et al*., 1975; Loch and Donnolan, 1982; Spink *et al*., 1998). Clay fraction of the soil is the site of nutrients and chemical adsorption (Young and Onstad, 7976; Frere *et al*., 1977). Soil clays can either be transported in primary or aggregated form (Young and Onstad, 1978; Foster, 1979). The soil loss is generally governed by the raindrop energy (Ellison, 1952). Rainfall intensity greatly affects the rate of soil detachment splash and run-off. The effect of soil erosion on physical properties of soil, soil types, soil profile and nutrient status has been discussed by Ekern (1950); Kowal (1970 a,b; 1972) and Lal (1976). Infiltration on the slopes in response to rainfall has been studied by Romkens *et al*., (1986).

Jones and Richards (1977) suggested that concentration of nitrate nitrogen in run-off water also depends on growth stage of vegetation. The role of vegetation to conserve soil and nutrients at wetland margins have been given by Singh and Ambasht (1990); Ambasht (1992, 1995); Ambasht and Ambasht (2003). Syers *et al*., (1973); Barrow (1978); Parfitt (1978) showed that phosphorus transport was greatly through water. This is mainly because of organic matter transported, contains relatively high level of phosphorus (Burwell *et al*., 1979; Nelson *et al*., 1979).

The present sites are situated at wasteland in district of Jalaun at Orai, U.P., India. There was about 90% of rainfall during the rainy season, in the experimental year 2016. The intensity and duration of rainfall events at the study sites are much responsible for the loss of water, soil and nutrients and plays important role in the stability of the ecosystem. Therefore, the present study has been conducted to see the impact of natural rainfall events (with different intensities and durations) during rainy season in vegetal cover and bare areas, which resulted the loss of soil, water and nutrients.



Model 1. Annual Soil loss(on/ha/yr.)at two study sites (I&II)Computed on the basis of total two natural rainfall (25 mm)

II MATERIALS AND METHODS

The present study was conducted in the south eastern part of the Orai city, (25^0 59′ N latitude and 79^0 37′ E longitude) at two different villages Dakor (site I) and Mokhari (site II) in Orai Tahsil during rainy season, 2016. At both the sites two plots were demarcated, each of 2m x 2m size. Each plot was enclosed by earthen bund of about 15 cm height from three sides. On each site, from one plot surface vegetation was scrapped or clipped and other plot was retained with natural vegetational cover. The vegetated cover at site-I was mostly dominated by *Cynodon dactylon* (Linn.) Pers, *Saccharum munja* Linn., *Cyperus rotundus* Linn. and at site II was *Desmostachya bipinnata* Linn., *Acacia nilotica* (Linn.) Del., *Saccharum spontaneum* (Linn.) Mont, *Digitaria adcendens* (H.B.K.) Heur, *Desmodium triflorum* DC., *Eragrostis uniloides* (Retz.) Nees etc. Towards the fourth side of the plot, where water drains down was not covered by bund wall completely. Pits of about 100 liters capacity were dug on this water receiving side. Before the rainfall, the pit bottom was covered with tin sheet, over which big polythene sheet was placed in such a way that the collected water could neither infiltrate down or permeate into the side walls of the pit. The main purpose is to expose two identical plots (one vegetated and other bare) of similar size of both study sites (I&II), in two different natural rainfall event i.e. 14 and 11 mm for 1 hr, 30 minutes and 1 hr 15 minutes on two different days during rainy season respectively. The quantities of the water run-off and weight of soil eroded and deposited in reservoirs from each of the vegetated and bare plots, were collected. The run-off water sampling was done immediately to avoid loss due to evaporation. The soil samples were collected and oven dried at 105^0C for 36 hrs and allowed to pass through 0.5 mm sieve before the analysis. A 0.45 mm pore size filter was used to separate under run-off and deposited soil for the estimation of nutrient content in soil and water separately. The following formula has been used (Singh and Sharma, 1984) to find out the percentage of soil or water which is retained by the vegetation as compared to bare plot run-off values.

$$C\upsilon = 100\ 1 - \frac{Sp}{So}$$

where, $C\upsilon$ = percentage conservation value,

Sp = quantity of soil or volume of water from the vegetated plot,

So = The weight of soil or volume of water from the bare plot.

In eroded soil total nitrogen analysis was performed by using micro-Kjeldahl method (Peach and Tracey, 1965; Misra, 1968) and available phosphorus was determined by chlorostannous reduced molybdophoric blue colour in hydrochloric acid (Jackson,1967).In run-off water total nitrogen and phosphorus was estimated by using the method described by APHA, (1985).

III RESULTS

The results of the present study have been depicted in Table 1. The run-off water values at site I were recorded 14.5 and 11 litres/4m^2 vegetated and 29.7 and 24.1 litres/4m^2 (bare) for 14mm and 11mm rainfalls, respectively. The $C\upsilon$ values were recorded 48.29% and 51.27% for two respective rainfalls. In contrast, water run-off values at site II were noted 10.7 and 7.1 litres/4m^2 (vegetated) and 24.1 and 17.4 litres/4m^2 (bare) for two 14 and 11 mm rainfalls respectively. Whereas the $C\upsilon$ values were recorded 52.06 and 54.56% in the respective rainfall events.

The soil erosion values at site I were observed 21.0 and 14.2 g/ 4 m^2 (vegetated) and 229.4 and 204.2 g/4 m^2 (bare) for 14 and 11 mm rainfall events, respectively. The $C\upsilon$ values were recorded 89.35 and 91.49% for two respective rainfalls at site I. In contrast, soil erosion values at site II were recorded 18.2 and 12.2 g/ 4 m^2 (vegetated) and 214.5 and 199.5 g/4 m^2 (bare) during two respective rainfall events. The $C\upsilon$ values were recorded 90.03 and 92.36% for two rainfalls, respectively.

The soluble nitrogen concentration values at site-I in run-off water were observed 0.0371 and 0.0243 g/4 m^2 (vegetated) and 0.1930 and 0.1345 g/4 m^2 (bare) for 14 and 11 mm rainfalls, respectively. The $C\upsilon$ values were recorded 79.02 and 80.16% in two respective rainfalls. In contrast, at site II, its values were 0.0104 and 0.0102 g/4 m^2 (vegetated) and 0.0741 and 0.0684 g/4 m^2 (bare) during first and second rainfalls, respectively. Whereas $C\upsilon$ values were recorded 83.60 and 83.78% for two respective rainfall events.

The soluble nitrogen values in eroded soil at site I were 0.0332 and 0.0301 g/4 m^2 (vegetated) and 0.1220 and 0.1100 g/4 m^2 (bare) for two rainfall events. In contrast, at site II these values were 0.0270 and 0.0224 g/4 m^2 (vegetated) and 0.1109 and 0.0944 g/4 m^2 (bare) for first and second rainfall events. The $C\upsilon$ values were recorded 73.57 and 74.28% for two respective rainfall events.

The soluble phosphorus concentration in run-off water, at site I was 0.0301 and 0.0171 g/4 m^2 (vegetated) and 0.3180 and 0.1011 g/4 m^2 (bare) for first and second rainfall events, respectively. The $C\upsilon$ values were 79.49 and 81.08% in the two respective rainfalls. However, at site II the values were 0.0201 and 0.0106 g/4 m^2 (vegetated) and 0.1330 and 0.0841 g/4 m^2 (bare) during the first and second rainfall events, respectively. The $C\upsilon$ values were 83.75 and 85.16 % in two respective rainfalls.

The soluble phosphorus concentration values in eroded soil, at site I were 0.0044 and 0.0030 g/4 m^2 (vegetated) and 0.0143 and 0.0111 g/4 m^2 (bare) for first and second rainfall events, respectively. The $C\upsilon$ values were recorded 63.44 and 66.10% in two respective rainfall events at site I. In contrast, the

Table 1. The water run-off, soil loss and loss of nutrients (N&P) through soil and run-off water at site I & II in about 14 mm natural rainfall during 90 minutes and 11 mm natural rainfall during 75 minutes in rainy season on two different days, in the study period.

Nutrients	Site-I				Site – II			
	Rainfall (mm)	Vegetated plot (2m x 2m)	Bare Plot (2m x 2m)	Cv(%)	Rainfall (mm)	Vegetated plot (2m x 2m)	Bare Plot (2m x 2m)	Cv(%)
Water run-off (liters/4m²)	14	14.50	29.70	48.29	14	10.70	24.10	52.06
	11	11.00	24.10	51.27	11	7.10	17.40	54.56
Soil loss (g/4m²)	14	21.00	229.40	89.35	14	18.20	214.5	90.03
	11	14.10	204.20	91.49	11	12.20	199.5	92.25
Nitrogen loss through	14	0.0371	0.1930	79.02	14	0.0104	0.0741	83.60
Water (g/4m²)	11	0.0243	0.1345	80.16	11	0.0102	0.0684	93.78
Nitrogen loss through	14	0.0332	0.1220	71.01	14	0.0270	0.1109	73.57
Soil (g/4m²)	11	0.0301	0.1100	71.43	11	0.0224	0.0944	74.28
Total flow of Nitrogen	14	0.0714	0.3160	76.01	14	0.0385	0.1850	77.62
(g/4m²)	11	0.0550	0.2450	76.12	11	0.0320	0.1640	79.00
Phosphorus loss through	14	0.0301	0.3180	79.49	14	0.0201	0.1330	83.75
Water (g/4m²)	11	0.0171	0.1011	81.08	11	0.0106	0.0841	85.16
Phosphorus loss through	14	0.0044	0.0143	63.44	14	0.0032	0.0123	66.20
Soil (g/4m²)	11	0.0030	0.0111	66.10	11	0.0021	0.0104	71.06
Total flow of Phosphorus	14	0.0346	0.3340	88.21	14	0.0234	0.1458	82.21
(g/4m²)	11	0.0211	0.1133	79.48	11	0.0140	0.0960	83.48

values of soluble phosphorus at site II were 0.0032 and 0.0021 g/4 m^2 (vegetated) and 0.0123 and 0.0104 g/4 m^2 (bare) for first and second rainfalls, respectively. The Cv values were recorded 66.20. and 71.06% in the two respective rainfalls at site II (Table 1).

The annual soil loss has been experimentally computed on the basis of total natural rainfall (i.e. 1146.6mm) as depicted in Model-1. It showed that annual soil loss was 2.01 (vegetated) and 24.86 ton/ha/yr (bare) at site I and 1.74 ton/ha/yr (vegetated) and 23.73 ton/ha/yr (bare) at site II. The value of annual soil loss was lower than work done at slopes around railway track i.e. 5.30 (vegetated) and 44.40 ton/ha/yr (bare) by Kapoor (2005). The annual soil loss was higher at site-I in comparison to site-Il in both vegetated and bare plots.

IV DISCUSSION

On perusal of data the vegetated and bare plots of two sites (I & II) for the loss of water, soil and nutrients (N&P) through water and soil, it seems that the vegetation cover protects the soil and nutrients from heavy-impact of rain drops very effectively, The values of loss of water 24.36 and, 31.66% (vegetated) and 18.18 and 26.59% (bare) were more at site I in comparison to site II in the two respective rainfall events. Similarly, the loss of soil was 12.27 and 12.50 (vegetated) and 6.46 and 2.29% (bare) higher at site I as compared to site II. It may be attributed to higher degree of slope and less vegetation cover at site I than site IL The values of water and soil loss were slightly higher than work done at Surhatal (Ballia) Iake and surrounding wetland by Ambasht (1998) but lower than Ganga river bank (Srivastava, 2003). Vegetation cover along with plant residues obstructs run-off velocity and reduces soil transporting capacity (Baver, 1956). Initial reduction in water drop energy by multilayered canopy cover was discussed by Singh (2003).

The loss of nutrients (N & P),through water as well as through soil were higher in 14mm rainfall in comparison to 11mm rainfall at both the sites (I & II). It may be due to higher intensity and duration of 14mm rainfall than 11mm rainfall. It is because of rainfall intensity is more important than rainfall amount for causing erosion (Nicholas and Sexton, 1932). The nitrogen and phosphorus concentration was observed higher in run-off water because they are closely associated with moisture content of soil (Burwell *et al.*, 1975; Alberts *et al.*, 1980).

The loss of nutrients N & P) through water and soil were higher at site I as compared to site II. It may be due to slightly higher degree of slope and severe biotic factors but less vegetational cover at site I, which ultimately exposed more soil surface for beating raindrop effect and causes more erosion.

The difference in total degree of erosion in vegetated and bare sites I & II may be attributed to the different soil texture and structure of the two sites.

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