CHAPTER V

ASSESSMENT OF SOIL EROSION OF THE RAYENG BASIN

5.0 Scenario of soil erosion

For managing watershed, assessment of soil erosion is indispensable. It is obvious that combating the erosion of soil and investing in its conservation for future generation is an essential task promoting sustainable development and protection of nature. The application of scientific techniques and introduction of new methodologies to handle with the wide spread problem of soil erosion has become crucial to protect cultivable and uncultivable lands from the threat of erosion, improve and reinstate soil productivity and restore degraded soil. Normal erosion is a continuous natural process where soil is regenerated by naturally at almost the same rate as it is eroded. But when protective vegetal cover is detached by cultivation, grazing or burning, the natural balance is distorted and soil become uncovered to most serious causes of erosion, i.e., water and wind. Under these circumstances the soil can be eroded away at a faster rate than it can regenerate resulting in a net loss of soil. It causes exposure of bed rocks and silting of rivers and dams.

In the Reyang Basin two types of soil erosions are observed, one is the natural erosion and another is the accelerated erosion. Natural or normal geologic erosion is the erosion of land in its natural state, undistributed by human activity. Uneven land surface are being continually eroded by running water. Accelerated soil erosion takes place when the ecosystem is additionally disturbed by the action of man and sometimes by animals and if the disturbances of such dimension are that nature cannot cope with it.

5.1 Methodology

To assess the extent of soil erosion the 'USLE' equation is applied. A set of factors as identified in 'USLE' are studied and viewed in the basin area. These take account of rainfall erosivity factor (R factor), Soil erodibility factor (K factor), Slope and slope length factor (LS factor) and conservation practices factor. These factors are considered using Satellite imageries, topographical sheet and rainfall data from IMD. Attempts have been made to develop soil loss equation from values of parameter influencing soil erosion under a set of conditions of slope, climate, rainfall, crop management and conservation practices on such the USDA Handbook No. 537 (Wischmeier and Smith, 1978). The USLE is defined as follows:

A = RKLSCP

A = Computed soil loss per unit area.

R = Rainfall factor, rather the erosion index (EI) which is the product of kinetic energy of the storm times the maximum 30 minutes intensity.

K = Soil erodibility factors which is the average soil loss per unit area per unit of erosion index from a cultivated fallow plot.

L = Slope percentage factor.

C = Crop management factor, this is the rotation of soil loss under a specific cropping system to that of the fallow plot, and

P = Erosion control or soil conservation practice factor (such as strip cropping, contour farming).

While USLE is widely used through various modified versions, its application in mountainous terrain with steep slopes is still questionable. Some models, such as AGNPS or ANSWER, are used for the assessment of soil erosion. These models are difficult to apply for Rayeng Basin for the lack of available data. Considering all these, the model developed by Morgan, Morgan and Finney (Morgan et al., 1984) is used in the present study to assess soil loss from Rayeng Basin. This model is selected for the study as it is simple and has strong physical phase.

5.2 Rain erosivity factor (R factor) of the basin

The intensity, amount (quantity), duration and distribution of rainfall are the most significant components of rainfall factor which determine the nature and degree of soil erosion. Rainfall is intimately related to soil loss in two ways one is the detachment of soil through striking the soil surface and another one is that rainfall contributes the runoff for the erosion of the top layer of the soil. Erosivity of rainfall is suitably uttered by an index based on the kinetic energy of the rain. The erosivity of a rain storm is a function of its intensity and duration, and of the mass, diameter and the velocity of the rain drops. For computing erosivity of rain it is essential to analyse the drop size distribution. Laws and Parsons (1935), based on the study of rain in the eastern USA, show that drop-size characteristics vary with the intensity of the rain with the median rain drop diameter (d50) increasing with rainfall intensity. Studies of tropical rainfall (Hudson 1963) indicate that this relationship holds only for rainfall intensities up to 100mm/h. At the higher intensities, medians drop size decreases with increasing intensity, presumably because greater turbulence makes larger drop size unstable. R factor is the coefficient of the average erosion by rain (J/m^2). Rain is a direct impact to the surface of soil; its kinetic energy is destroying the soil structure and brings the soil components together with runoff water. According to Wischmeier and Smith (1978), the R coefficient is calculated based on maximum rain volume in 30 minute, the equation is following:

$R = EI\ 30/1000$

In which: E is kinetic energy of the rain

I is the maximum rain volume in 30 minute (mm/h)

The rainfall energy is computed from the total annual rainfall and the hourly rainfall intensity for erosive rain, based on the relationship established by Wischmeier and Smith (1978). The annual volume of overland flow is predicted using the model by Kirkby (1976). In this model, the runoff is assumed to occur whenever the daily rainfall exceeds a critical value corresponding to the storage capacity of the surface soil layer. Equations used are given below:

For calculating the rainfall energy:

$$E = R\,(11.87 + 8.73 \log10\, I)$$

Where,

E = kinetic energy of rainfall (J m^2)

R = annual rainfall (mm)

I = rainfall intensity (mm/hr)

For assessing soil erosion, rainfall intensity is very important since splash detachment is a function of rainfall energy, soil detachability and rainfall interception by crops. The rainfall energy is directly related to rain intensity (Wischmeier and Smith, 1978). However, not all rainfall events are erosive. Rain showers of less than 12.5mm are assumed too small to have practical significance and are not considered erosive (Wischmeier and Smith, 1978). In the Rayeng basin to record enough number of the Ei is difficult, so the equation is hardly applied in this basin. Several empirical methods have been devised many experts as follows

Method I: Rose (1975), R= 0.5xP (P is the mean annual rainfall)

Method II: Morgan (1974), Mean annual erosivity (KE>25), R= 9.28P – 8,838 multiply by I30 (use 75mm/h; maximum value recommended by Wischmier and Smith 1978) and divided by 1,000 to give value in metric unit.

Method III: Foster et al. (1981), Mean annual EI30 (Kg.m.mm)/ (m^2.h) with this unit, divide by 100 to give R value in metric unit.

In case of Rayeng basin rainfall data (Table 5.0) is considered in terms of meteorological data of Darjeeling hill area as the basin occupying the parts of three hill subdivisions of Darjeeling district.

Table 5.0 Rainfall of Rayeng Basin.

Year	Rainfall in mm	Average no. of rainydays
2008	3463.90	136
2009	3274.90	
2010	3234.20	

Source: Hydromet Division, Meteorological Department, India

Table 5.1 value of R (rainfall erosion index) of Rayeng Basin.

Year	Method I	Method II	Method III
2008	2996.27	1748.02	717.02
2009	2832.79	1616.48	667.90
2010	2797.58	1588.15	669.47
Average	2875.56	1650.88	684.79

Based on calculation by the Researcher.

Discard result (Table 5.1) from method III which is rather low. Thus average value of method I and II are considered. Hence the R value is 2263.22. From study of meteorological data of last three years of this basin it is observed that average rainfall of the basin is about 3000 mm. Generally highest rainfall is occurred in the month of July (about 632.33 mm). From mid of June heavy down pour is started with the arrival of south-west monsoon. So soil erosion problem is most vulnerable during rainy in the season .The rainfall intensities in this basin may vary from 5 mm to 160 mm per hour. In the rainy season mainly from the month of June to August the average diameter of the rain drop falling in this basin is about 5 mm having terminal velocity of about 9 meters per second. Thus Kinetic energy of rain or rainfall energy of rain drops resulted to break down of soil aggregates of the basin. Along with it turbulence surface run off carry away huge soils of this basin to the downstream .Temperature also affects, through indirectly, the nature and rate of soil erosion of this basin. Alternative wetting and drying of soil causes hydration and dehydration of thin soil layer having montmorillonites. This process causes expansion of soil particles which weaken the soils. These cracks are filled with water during the next rains and thin layer of the soils become as soft as curd and slumps run off. This mechanism of soil erosion is also found in this basin.

5.3 Soil erodibility (K factor) of the basin

The soil erodibility factor (K-factor) is a quantitative description of the inherent erodibility of a particular soil; it is a measure of the susceptibility of soil particles to detach and transport by rainfall and runoff. For a particular soil, the soil erodibility factor is the rate of erosion per unit erosion index from a standard plot. The factor reflects the fact that different soils erode at different rates when the other factors that affect erosion (e.g., infiltration rate, permeability, total water capacity, dispersion, rain splash, and abrasion) are the same. Texture is the principal factor affecting K, but structure, organic matter and permeability also contribute anticipated and a site analysis is unavailable. K factor is related to the erodibility of soil which refers to the resistance of the soil to erosion or its vulnerability to soil erosion. Soil characteristic such as management practice affects erodibility of soils which in turn together with eroding power of the process (erosivity) determines the nature and magnitude of soil erosion. The two most significant soil characteristics influencing soil erosion are:

a) Infiltration capacity is influenced greatly by structural stability, especially in the upper soil horizon.
b) The stability of soil aggregates affects the extent of erosion by drainage in another way. Resistance of surface granules to the beating action of rain saves soil even though runoff does occur. The marked granule stability of certain tropical clay soils high in hydrous oxides of iron and aluminum accounts for the resistance of these soils to the action of torrential rains.

It is very difficult to determine the actual erodibility of soil. In case of Rayeng Basin it is also difficult due to paucity of accurate date. To determine the soil erodibility of Rayeng Basin both Morgan's and Stewart's tables (Table 5.2 & Table 5.3) of K values are used.

Table 5.2 Soil Erodibility Factor K_{fact} (After Stewart et al. 1975).

Textural Class	**P_{om} (%)**		
	<0.5	2	4
Sand	0.05	0.03	0.02
Fine sand	0.16	0.14	0.10
Very fine sand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy fine sand	0.24	0.20	0.16
Loamy very fine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Fine sandy loam	0.35	0.30	0.24
Very fine sandy loam	0.47	0.41	0.33
Loam	0.38	0.34	0.29
Silt loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy clay loam	0.27	0.25	0.21
Clay loam	0.28	0.25	0.21
Silty clay loam	0.37	0.32	0.26
Sandy clay	0.14	0.13	0.12
Silty clay	0.25	0.23	0.19
Clay		0.13-0.2	

Table 5.3 Soil parameters used in the model
(Morgan et. al., 1984).

Surface texture	Soil detachability index
Coarse texture (less than 15% clay: sandy loam, loam)	0.3
Medium texture (less than 35% clay: loam, sandy clay loam, silty clay loam)	0.4
Fine texture (more than 35%clay: silty clay, sandy clay)	0.4

Table 5.4 K value of different textural category of soil the Rayeng basin.

Textural category of soil	Morgan model	Stewart model
Coarse Sand and Gravel	0.3	0.05
Sands	0.3	0.03
Sandy loam	0.3	0.24
Radish Sandy Loams	0.3	0.24
Loams and Silt Loams	0.4	0.32
Clay Loams, Silty Clay Loams	0.4	0.48
Silty Clays and Clays	0.4	0.23

Note: Soil detachability values are taken from the typical values adapted by Morgan et al (1982) and Stewart (1975).

From the calculation on K values (Table 5.5) of different category of soils of Rayeng Basin an average value of K is taken as 0.11. In the Rayeng basin mostly brown forest soil is dominant. The forest soil of this basin is enriched in organic matter and developed under forest cover. At the downstream sandy soil is developed clay is also found in different patches within this basin. Except clay soil mentioned other soil have less structural stability. Thus vulnerable soil erosion is occurred in major portion.

5.4 Topographic factor (LS) of the basin

Theoretically, a doubling of the velocity enables water to move particles 64 times more. The length of the slope is of prime importance since the greater the extension of the inclined area the greater is the concentration of flooding water. From different study it has been observed that doubling the length of 9 (nine) percent slope increased the loss of soil erosion by 2.6 times and the runoff water by 1.8 times. This influence of slope is, of course, greatly modified by the drainage area. Another modifying factor is the presence of channels, not only in the eroded area itself but in the watershed. The LS factor of slope length (L) and slope steepness (S) are combined in a single index which express the ratio of soil loss under a given slope steepness and slope length to the soil loss from the standard condition of a 5° slope, 22 m long, for which LS = 1.0.

The appropriate value can be:

$LS = (X/22.13)^{m} (0.065 + 0.045 S + 0.0065 S^2)$

Where X = Slope length (m) and S = slope gradient (%)

M = Exponent, for convex slope = 0.5, concave slope = 0.14, straight slope = 0.4

To calculate the LS- factor of the Rayeng Basin contour map is prepared form the topographical maps bearing the number 78 A /8 and 78 B/5 having scale 2 cm to 1 Km. For better analysis of the topographic factors the entire basin is divided into three altitudinal zones Viz. 1000-2400m (convex slope), 500-1000m (concave slope), 200-500m (straight slope). Slope percentage is derived from contour map of the study area and slope length was assumed to be fixed as 20m. Exponential value (m) is taken from the aforesaid equation. For the assessment of soil erosion of the total (Table 5.5) basin average value of LS- factor is taken into consideration. Detail calculation is given below:

Table 5.5 LS- factor of Rayeng Basin.

Altitudinal zones(m)	Slope length (m)	Slope in degree	Category of slope	Slope steepness (%)	LS- factor
1000-2400	20	14	Convex	23	4.31
500-1000	20	17	Concave	27	6.19
200-500	20	27	Straight	10	1.10
Average					3.86

Source: Topographical maps, land use map and calculation based on the equation given by Wischmeier and Smith 1978.

5.5 Biological erosivity (C.P. factor)

Vegetation factor is a dominant control factor of soil erosion because it intercepts the rainfall through its canopy and trees protects the ground surface from direct raindrop impact ,allows maximum infiltration of rain water, decrease surface runoff because of more infiltration, reduces the rate of detachment of soil particles, its roots effect increase soils strength, granulation and porosity. Acts as insulator of soil against high and low temperature .From the topographical sheet and satellite imagery and land use map the vegetation scenario is vividly revealed. Although there are two remarkable reserve forests such as Takdah and Reyang but in the remarkable part of the basin vegetal covers have been removed due to encroachment of human settlement. Sloping fields, especially those cultivated erode easily if the rate of water runoff is not slowed down. Even sod and close-growing crops do not give sufficient protection under these conditions specific practices used to be slow the water runoff include contour tillage strip cropping and terracing. In the

Rayeng basin people are practiced terrace cultivation without any scientific conservation method. Tea, Cinchona, Citrus fruits and in the lower part of the basin paddy are cultivated.

C - factor and P- factor (Table 5.7) of the Rayeng Basin has been estimated based on the C - factor and R- factor values for the Universal Soil Loss equation after Wischmeier and Smith (1978); Roose (1977); Singh, Babu and Chandra (1981); El-Swaify, Dangler and Armstrong (1987); Hashim and Wong (1988).

Table 5.6 C and P factor of the Rayeng Basin.

Land use	**Average annual C factor**	**P (%)**
Plantation	0.01	0.60
Grazing land	0.01	0.05
Dense forest	0.001	0.90
Degraded forest	0.01	0.05
Rain-fed crops	0.07	0.50
Rice cultivation	0.01	0.50
Bare soil	1.00	0.01
Average	0.16	0.37

For the assessment of soil loss of the basin average values of C and R factor are taken into consideration.

5.6 The potential soil erosion of the basin

Rayeng Basin is characterized by mountain ridges, having very sharp crests on augen and banded gneiss of various grade of metamorphism and mixtures of micaschist, phyllite and gneiss. Rayeng is the main river of this basin fed by many tributaries. The valley is narrow and deep, but widens downstream. At higher elevations, land cover is mostly forest which consists of chirr pine (*Pinus roxburghii*) and broad leaf trees (*Schima Wallichii,* local name Chilaune). In the cultivated areas, rained maize and millet are grown. A vast area of the basin is covered by cinchona and tea plantation. At lower altitudes, sal forest (*Shorea robusta*) dominates; crops include rainfed maize and millet. The basin has distinct altitudinal zones; mountains with very high ridges and narrow valleys (1000-2400m); mountains with high ridges and narrow valleys (500-1000m); mountains with medium ridges and narrow valleys (200-1200m). Lower valley area is undulating terrain. Annual precipitation also varies according to elevation changes. Most of the rainfall occurs during the months of June to September. Different textural category of soils has been developed in the Rayeng Basin area. Few conservation methods are practiced in the basin area. To compute the potential soil erosion, the entire basin has been divided into 1sq. km (100 hectare) grids. To estimate the potential of total soil loss of the basin the values of different factors of soil erosion used in USLE model taken from the calculation of different factors of the Rayeng Basin. On the basis of computed value (Table 5.8) the entire basin has divided in different soil erosion zones (Figure 5.0).

Table 5.7 Potential soil erosion of Rayeng Basin.

Rate of soil erosion (tonnes/hectare/yr)	Area (hectare)	Area (%)
< 10	1255.665	8.63
11-20	2940.555	20.21
21 -30	8530.665	58.63
> 30	1815.840	12.48

Based on calculation by the Researcher.

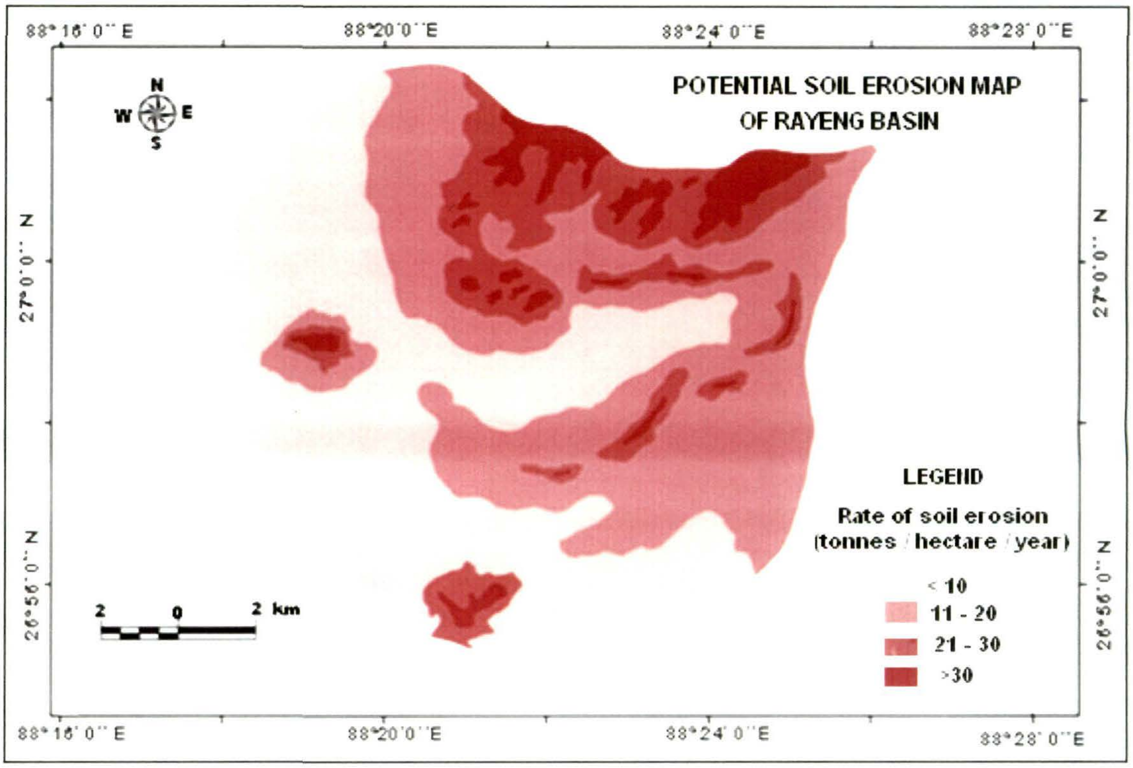

Figure 5.0 Assessment of soil erosion of the basin.

5.7 Field measurement of soil erosion

Field measurement may be classified into two groups; those designed to determine soil loss from relatively small sample areas or erosion plots, often as part of an experiment, and those designed to assess erosion over a large area such as drainage basin (R.P.C. Morgan, 1982). Several techniques are used to measure the soil erosion in the field such as, bounded plot, splash erosion measurement, rill erosion measurement etc. These appreciable methods were not applied to measure soil erosion in the Rayeng Basin on account of limited capacity of the author. Thus a very simplified technique (Figure 5.1& Table 5.9) was used to measure the soil erosion of the study area. Following were the steps of the mentioned technique:

1. Some plots were chosen for the study of soil erosion in the downstream area near the confluence of Rayeng River with Tista River. The area of the plot was 39.6 sq.m or 0.00396 hectare (22m long and 1.8m width).
2. In the chosen plots few pegs having length of 50cm were fully penetrated in the soil.
3. In consecutive years of study, the portion of the pegs, which were exposed (in one year duration) on the surface due to erosion of soil above those pegs measured.
4. Measuring length of the exposed portion of the iron pegs were multiplied by the plot area to get the volume of soil loss of the concerned plot. Weight of one unit of soil of the concerned plot was calculated and multiplying with total volume of eroded soil, amount of soil loss measured. The technique can be explained in the following equation:

$$SE = V \times W$$

Where,

SE = weight of the eroded soil

V = Volume of eroded soil in cubic unit (Ax I)

A = Area

I = Length of the peg exposed.

W = weight of eroded soil per cubic unit

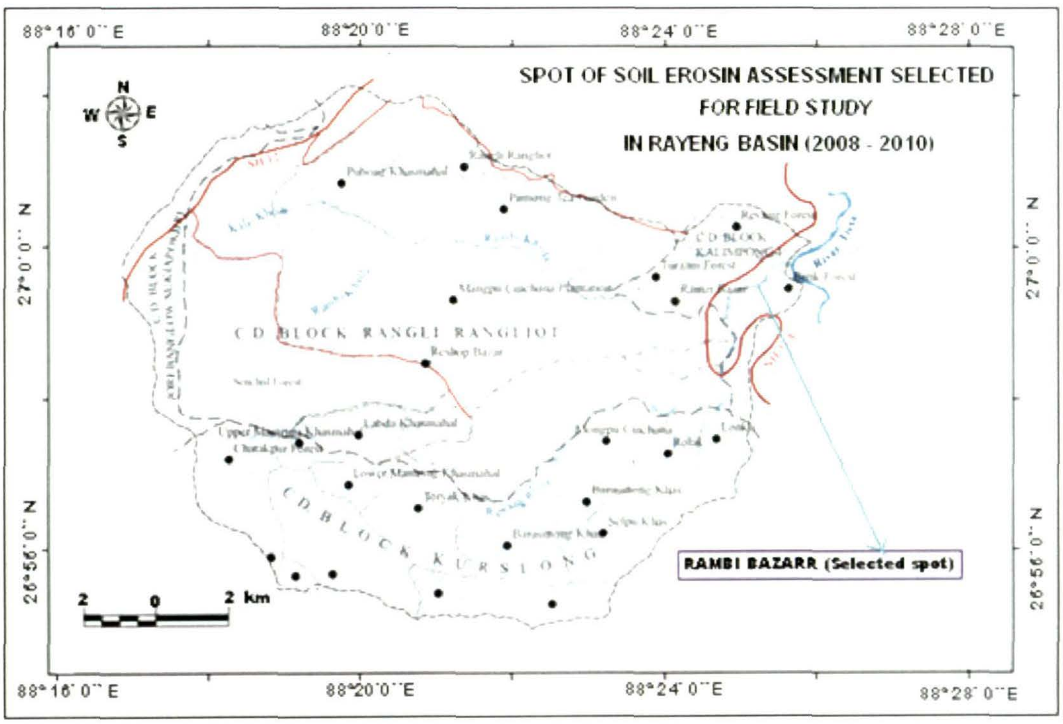

Figure 5.1 Selected spot for field study of soil erosion.

Table 5.8 Measurement of soil erosion at Rambi Bazar on the left bank of Rayeng River near the confluence with Tista River.

Name of the plot	**Area of the Plot (sq. m)**	**Amount of soil erosion in kg. /year**			
		2008	2009	2010	**Average**
A	39.60	69.30	67.40	68.30	68.33
B	39.60	62.30	60.40	63.50	62.07
C	39.60	68.30	60.00	62.50	63.60
D	39.60	52.00	48.00	50.00	50.00
E	39.60	49.00	49.60	48.70	49.10

Source: Field study.

Discussion

Results obtained by running a soil erosion assessment model (Morgan et al., 1984) shows that annual soil loss rates are the maximum (up to 36 tonnes/ha/yr) in the areas with steep slope cultivation, which is directly related to the sloping nature of the terraces. The lowest soil losses (< 2 tonne/ha/yr) are recorded under dense forest. In the degraded forest, the soil loss varies from 4 to 11 tonnes/hectare/year and in the grazing lands it is estimated at 12 tonnes/ha/yr. Tea plantations area suffers from severe soil erosion.

From the field observation (Table 5.9) it revealed that at the confluence of Rayeng with Tista River, soil erosion is remarkable on the valley sides are having moderate slope. Measurement of soil study of six selected plots at Rambi Bazar indicates that average rate of soil erosion of the plots is 58.62 kg. / Year. Each plot is having area of 39.60 sq.m (0.00396 hectare). It can be computed that rate of soil erosion in selected section is 14.80 tonnes. On the steep slope the rate of soil erosion is high than the moderate and low slope area. Vigorous soil erosion is mainly concentrated in the rainy season (June to August) Soil erosion is accelerated by the human activities mainly on the vulnerable slope. Rills and gullies are the main are the natural tools of the soil erosion of the Rayeng Basin.

5.8 Proposed soil conservation plan for Rayeng Basin

While the most important agent of soil erosion in the Rayeng Basin is water, soil conservation of the study area ought to take into account the following strategies:

1. Protect soil from the impact of rain drops.
2. Check water from intent and moving down the slopes in a constricted path.
3. Unhurried down water movement when it flows along the slope.

To minimize the problems of soil erosion in the Rayeng Basin following well known method may be suggested.

Biological method:

A. Agronomic practices

Agronomic practices for soil and water conservation assist to interrupt rain drops and lessen the splash effect, help to obtain better water ingestion rates by the soil by improving organic matter content and soil structure. They also help to slow down and decrease surface runoff through the use of contour cultivation, mulching, densely growing crops, strip cropping and mixed cropping. Methods mentioned below are to be followed, where agriculture is practiced.

1. Contour farming

Contour farming affords the most useful method of controlling runoff. By performing farming operations, such as tillage and planting, across the slopes keeping the same level as far as possible, this method aims at increasing the resistance to overland flow of water so as to assist greater infiltration. The plough furrows are shallow and hold the light rains till they are wrapped up by the soil. In case of intense rains, the thick stands of plants hinder the stream flow and lessen the velocity of runoff. The ridges and rows of plants positioned across the slope form a frequent series of small barriers to the water moving over the soil surface. The barriers are small individually, but as they are great in number they have the net effect of reducing runoff and soil erosion, and enhancing plant nutrient content.

2. Mulching

Mulching is the process of cover the soil between rows of crops with a layer of crop residues or mulch. Materials such as maize stalks, potato tops etc. are used as mulch. A defensive layer of 2-3 inch thickness formed by the stubble is fairly well-organized mulch. Mulching can reduce the blow of rain drops on the soil (splash effect).

3. Strip cropping

Strip cropping is one form of rotation and it is the practice of growing alternating strips of different crops in the same field. It is a very proficient method for controlling runoff and wind erosion.

A. Contour strip cropping

Contour strip cropping is the increasing of soil exposing and erosion permitting crops in strips of proper width across the slopes on contour, alternating with strips of soil defensive and erosion resisting crops. Contour strip cropping shortens the length of the slope, checks the movement of runoff water, helps to desist it and increases the absorption of rain water by soil. Moreover, the dense foliage of erosion resistant crops prevents the rain from thrashing the soil surface directly.

B. Field strip cropping

It is the planting of farm crops in more or less parallel strips across fairly uniform slopes but not on exact contours.

C. Buffer strip cropping

Perennial legumes or shrubs are planted in a field with contour strip cropping, especially in steep and highly eroded slopes. These buffer crops protect the main rotational crops in the field. Buffer strip cropping may be employed whichever as a short-term or enduring method.

1. Lye farming

On sloping lands, it adapts well with other annual crops forming a multiple cropping system in alternate rows to carry out this task. In high rainfall areas, where soil erosion is a serious problem, Guinea grass can be used to achieve the double objectives of fodder producing and soil conservation. In sloping terrain where earthen bunds are used to check soil erosion, raising the grass on the bunds at an interval of 20cm between plants, will make stronger the bunds.

2. Mechanical methods

Mechanical methods are adopted to supplement the agronomical practices when the latter are not quite effective. Mechanical measures comprise basin listing, sub-soiling, contour bonding, graded bonding and bench terracing on steep slopes.

A. Basin listing

Basin listing involves making a number of interrupting basins by a basin lister. The slope is converted into a series of smaller interrupted basins along the contour. The method helps in holding rain water as it falls and is quite effective for retentive soils along mild slopes.

B. Sub-soiling

In sub-soiling, the hard and impermeable sub-soil is broken down with a sub-soiler. This procedure does not involve the inversion of the soil but improves its physical condition, promotes better moisture penetration into the soil and reduces runoff, thereby minimizing soil erosion.

C. Contour bonding (Level terraces, Ridge-type terraces)

Contour bonding, as well as called level terraces or ridge-type terraces, consists of constructing comparatively narrow based embankments at intervals crossways the slope of the land on a level along the contour.

D. Bench terracing

In bench terracing, a series of platforms are made having appropriate vertical drops along contours on suitable graded lines crosswise the general slope of the terrain. The vertical drops may vary between 60cm and 180cm. Bench terracing can be either 'table top' or sloping out ward or inward, with or without a slight longitudinal grade. Bench terracing helps to carry out intensive farming on steeply sloping and undulating land.

E. Contour trenching

This method involves the digging of trenches of suitable length about 2 feet deep and 1 foot broad crosswise the slope of the fields. The soil which is taken out from the trenches is used in the formation of bunds along the lower edges. Tree seedlings are planted along these trenches.

3. Other methods

A. Gully erosion control

Gully erosion control is essential and requires to be implemented urgently in Rayeng Basin because it has been affected by severe gully erosion. These gullies are indications of the poor management of land resources. Gully erosion can be effectively controlled by planting of trees and shrubs in ravines.

B. Watershed treatment

Soil loss can best be tackled by jacket the watershed with vegetation comprising multistate trees, shrubs and grasses. The deteriorated or threatened area is covered with fast growing plant species followed by long–maturing trees with deep roots to restore the original condition.

C. Controlling landslides

Landslides are a more severe problem in the Himalayas than to another place. Control methods depend on the kind of materials available in the area, the cause of the problem and the type and rate of movement of the slide. These factors vary so greatly from slide to slide that details of remedial measures are required to be tailored for each slide.

Last but not the least that some strict rules are to be implemented by the administration to protect illegal cutting of trees, haphazard and unplanned development of settlement and construction work avoiding the knowledge of geology and ecological aspects. A natural geomorphic characteristic of the Basin is being disturbed by addition loads aided by excessive soil erosion. Thus to maintain the natural characteristics of the basin excessive soil erosion should be cheeked.

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