CHAPTER VII

EFFECT OF ENVIRONMENTAL DEGRADATION IN RAYENG BASIN

7.0 Situation of environmental degradation

Alteration is a linked and natural part of all ecosystems. Though, human interruption has introduced a source of change that is overseas to the geomorphic and biotic conditions of river systems. Human interruption has modified the nature and rate of river adjustments, changing the spatial and of time distribution of river forms and processes. Hydrological imbalances presently observed in the Himalaya are considered to be linked to the loss of vegetation cover. Further these two factors under the influence of the geomorphological forces in geologically active belts exacerbate the process of landslides and erosion. These phenomena apart from directly deteriorating the local environment have significant implications for the adjoining regions too (K.S. Rao, 2004). However, Hamilton (1987) while summarizing the information available indicated that "at a local level, sediment load is strongly influenced by human activity, stream discharge characteristics. At the medium level downstream of the catchment being impacted, it is still uncertain what the quantitative effects of human activity could contribute, but the high variability of natural factors dominates both stream discharge and sediment load. At the macro level in large basins, human impacts in the upper watershed are insignificant on lowland floods, low flows, and sediment but these effects can be significantly influenced by human activity in the lower reaches of the river".

Environmental degradation of a river basin alters the natural state and creates a variety of troubles for ecological stability and hydrological characteristics of a river. For the study of scale of environmental degradation of a river basin, it is essential to recognize different environmental units. For detail study of environmental situation of Raying Basin has been divided in different environmental units. To recognize environmental unit following methodology has been followed:

Methodology for assessing environmental degradation in Rayeng Basin

1. Identification of physical resource zones

To recognize environmental units, quantitative and spatial analyses of natural resources have done based on the existing sources in the basin. Following sources have been used to determine the environmental units:

A. Topographical map (scale 1:50000, 78A /8, 78A/5).

B. Aerial photograph.

C. Satellite imagery (IRS 1C LISS III – 19th January, 2002 and IRS P6 LISS III 26 January, 2006 (National Remote Sensing Agency, Hyderabad).

D. Land use map (Final report published by Prof. Mamta Desai, Project Coordinator Department of Ecology &Environment, Netaji Institute for Asian Studies).

E. Land capability map.

F. Landslide susceptibility map.

2. Quantitative measurement of ecological aspects

A variety of ecological processes such as water flow, soil erosion, runoff, sedimentation, etc. are associated to physiographic units. Many of these combinations of mechanisms entail the timing or behavior of biological life cycles and the net movement of nutrients and organic materials. Activities of human beings influence the ecology. Therefore, following quantitative analysis has done.

A. Measurement of discharge and sediment load of the streams.

B. Measurement of vegetal cover.

C. Magnitude of soil erosion.

D. Measurement of cultural and agricultural land use.

E. Study of geological and morphological map.

F. Study of manmade construction.

On the basis of the stated analysis the Rayeng Basin has been divided into different environmental units. Study of topographical maps, aerial photographs satellite imagery, land use map, land capability map, landslide susceptibility, following environmental zones have been recognized (Table 7.0).

Table 7.0 Different environmental zones and their characteristics.

Zones	**Characteristics**	**Location**
A. Altitudinal zones		
1. River valley zone (<300m)	Gentle slope, moderate soil erosions and moderate susceptibility of landslides	Northern part of pubong khasmahal of Birik forest, Rambi bazaar of Kalimpong-I
2. Lower hill zone (300m-600m)	Moderate to high slope, high of susceptibility of landslides and vegetal cover partially removed	Toryak khasmahal, Rolak, Lonku, Sittong khasmahal of Kurseong Blok
3. Upper hill zone: (600-2000m)	High to steep slope, very highly susceptible to landslides, vegetal cover removed in some places	Mongpu, Reshop bazaar, Labda Kashmahal of Ranglirangliot block
4. Hill summits zone (>2000m)	Very steep slope, thickly vegetal cover	Mongpu of Ranglirangliot block
B) Forest zone	Densely vegetate, less soil erosion and landslides	Upper Mamring, Lower Mamring khasmahal, Senchal forest area, Birik forest, Bhalukhop forest

C) Plantation zone	Vegetal covers removed, soil erosion and landslide prone	Mangpu of Rangli Rangliot block, Pubong tea garden area and other tea garden
D) Cultivation zone		Labda khasmahal, Resop bazar, Pupong Kashmahal of Rangli Rangliot block

Based on assessment by the Researcher.

Impact of environmental degradation in the Rayeng Basin has been assessed in terms of two aspects viz. disturbances in sediment transportation, deterioration of ecological balance.

7.1 Disturbance in sediment transportation

Quantity and transport rate of sediment load of a stream varies over time and by location. It controls by geology, channel boundary materials, channel stability, amount and type of rainfall of the basin area in natural condition. Human activity has to a great extent changed the yield of many rivers worldwide. Increases in yield are caused by accelerated soil erosion; mining and urbanisation. The yield of an increasing number of rivers has been reduced by the construction of large dams. Sediment is deposited in reservoirs, becoming trapped behind dams. In the Rayeng Basin, transportation of sediment disturbs by environmental degradation of the basin area. Constructional structure such as bridge, hydel project, and artificial channel diversion etc, can seriously disturbed the transportation of sediment load of a Rayeng River.

Plate 7.0 Deposition of boulders behind remains of a bridge at Rambi Bazar.

There is a correlation between flow regime and sediment characteristics of river interims of temporal and spatial changes in geometry of channel and bed material size (Hey, 1986). To determine the response of the channel to natural and man induced changes the interaction between channel form, flow regime and sediment transport must be studied. Reid (1996) stated that "alterations to the flow regime often affect sediment production and transport, while altered channel morphology occurs only through mobilization of sediment". Thus an assessment of sediment in a river is needed to determine potential or existing channel responses to alteration in land use. The total sediment load refers to the sediment transport rate and is defined as the total amount of sediment passing through a given channel cross-section per unit of time. Based on the type of total sediment load, several methods are available to evaluate the sediment component of a fluvial system. Such evaluations involve the development of particle size distributions, suspended sediment sampling, measurement of bed load transport, and the determination of changes in sediment storage. Many methods are to be conducted each of these evaluations. The method or combination of methods is dependent on the channel characterization and specific purpose of sediment evaluation.

Estimation of suspended load of Rayeng Basin

The simplest means of captivating a sample of suspended sediment is to plunge a bucket or other bottle into the stream, if at all possible at a point where it will be well assorted, such as downstream from a weir or rock bar. The sample is then filtered, dried out and weighed to provide a dry weight of sediment in milligrams (mg) when divided by the volume of the sample in liters (l) this gives a concentration in milligrams per liter (mg l^{-1}). Over time, a dataset of sediment concentration measurements is built up, each analogous to a different discharge. To calculate the total sediment load passing the recording station for that day, it is necessary to multiply the instantaneous concentration by the total volume of flow for the day.

Sediment load (kg) = sediment concentration

(Mg l^{-1}) × mean discharge ($m^3 s^{-1}$) × No. of seconds in a day

Since there are 86,400 seconds in a day, the numbers can get rather large. Therefore the daily sediment load is usually expressed in kilograms rather than milligrams (there are 1 million mg in 1 kg). Following gradation has been made for the analysis suspended load (Table 7.1)

Table 7.1 Gradation of suspended load.

Sl. No.	Types of grains	Diameter in mm
1	Coarse grained	0.2 -2.00
2	Medium grained	0.075- .200
3	Fine grained	<.075

In case of Rayeng Basin, it has not possible to have year round data of discharge, since there is no recording station within the basin. Therefore, seasonal data have been collected from two selected station. To assess the impact of anthropogenic activities on sediment transportation, one station was selected at the confluence of Rayeng with Tista River;

another station was 1.50km away on upstream above the residue of a bridge (Table 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8 & 7.9).

Table 7.2 Measurement of sediment loads at the confluence of Rayeng River with Tista River (Monsoon season).

Date	Cross section area (sq. m)	Discharge (m^3/s^{-1})	Suspended load of the river (kg/day) (Estimated)			
			Coarse grained	Medium grained	Fine grained	Total
14.7.2008	198.35	462.15	118.80	145.200	1056.00	1320.00
15.7.2008	196.05	450.00	114.80	140.200	1020.00	1275.00
16.7.2008	199.00	472.10	122.90	150.150	1092.00	1365.00
17.7.2008	197.35	460.15	120.60	147.400	1072.00	1340.00
18.7.2008	196.00	448.00	111.60	135.900	9880.00	1235.00
19.7.2008	195.15	452.00	114.90	140.500	1021.60	1277.00
20.7.2008	198.10	462.70	122.90	150.200	1092.00	1365.00
21.7.2008	196.30	458.00	115.70	141.500	1028.80	1286.00
22.7.2008	195.20	452.00	109.80	134.200	9760.00	1220.00
23.7.2008	196.00	455.05	115.90	141.900	1030.40	1288.00

Source: Field survey (2008).

Table 7.3 Measurement of sediment loads at 1.5 km on upstream from the confluence of Rayeng River with Tista, above the residue of the bridge (Monsoon season).

Date	Cross section area (sq. m)	Discharge (m^3/s^{-1})	Suspended load of the river (kg/day) (Estimated)			
			Coarse grained	Medium grained	Fine grained	Total
14.7.2008	175.20	462.15	271.60	162.00	923.40	1350.80
15.7.2008	176.20	438.10	275.00	165.00	935.00	1370.50
16.7.2008	174.10	450.00	266.60	159.90	906.40	1330.30
17.7.2008	173.00	444.25	264.00	158.60	897.60	1320.00
18.7.2008	173.05	440.10	264.40	158.60	898.90	1320.20
19.7.2008	172.90	438.20	262.20	157.30	891.40	1310.10
20.7.2008	174.00	441.00	270.00	162.00	919.00	1350.00
21.7.2008	174.00	441.05	270.30	162.18	919.00	1350.15
22.7.2008	173.10	440.10	268.20	160.90	911.80	1340.10
23.7.2008	175.20	441.05	268.2	160.90	911.80	1340.10

Source: Field survey (2008).

Table 7.4 Measurement of sediment loads at the confluence of Rayeng River with Tista River (Non-monsoon season).

Date	Cross section area (sq. m)	Discharge (m^3/s^{-1})	Suspended load of the river (kg/day) (Estimated)			
			Coarse grained	Medium grained	Fine grained	Total
27.12.2008	21.15	46.34	101.00	118.00	1470.00	1690.00
27.12.2008	21.15	45.02	96.00	112.00	1392.00	1600.00
27.12.2008	21.15	43.30	91.00	106.00	1318.00	1515.00
27.12.2008	21.15	44.00	86.00	100.00	1248.00	1430.50
27.12.2008	21.15	45.05	96.00	112.00	1392.00	1600.00
27.12.2008	21.15	44.00	102.00	119.00	1479.00	1700.00
27.12.2008	21.15	47.15	89.00	105.00	1306.00	1490.50
27.12.2008	21.15	43.00	98.00	115.00	1427.00	1640.00

27.12.2008	21.15	44.05	86.00	100.00	1244.00	1430.00
27.12.2008	21.15	46.00	90.00	106.00	1305.00	1500.00

Source: Field survey (2008).

Table 7.5 Measurement of sediment loads at 1.5 km on upstream from the confluence of Rayeng River with Tista, above the residue of the bridge (Non-monsoon season).

Date	Cross section area (sq. m)	Discharge (m^3/s^{-1})	Suspended load of the river (kg/day) (Estimated)			
			Coarse grained	Medium grained	Fine grained	Total
27.12.2008	18.25	62.42	10.90	12.70	158.30	182.00
27.12.2008	18.25	60.40	10.30	12.00	149.30	171.60
27.12.2008	18.25	55.00	9.80	11.40	142.10	163.30
27.12.2008	18.25	61.23	9.00	10.50	130.50	150.00
27.12.2008	18.25	59.05	10.90	12.70	157.40	181.00
27.12.2008	18.25	57.00	10.30	12.00	148.80	171.00
27.12.2008	18.25	60.15	9.70	11.30	140.50	161.50
27.12.2008	18.25	58.11	8.60	10.00	124.80	143.50
27.12.2008	18.25	56.25	10.20	11.90	147.90	170.00
27.12.2008	18.25	60.50	10.90	12.70	157.90	181.50

Source: Field survey (2008)

Table 7.6 Measurement of sediment loads at the confluence of Rayeng River with Tista River (Monsoon season).

Date	Cross section area (sq. m)	Discharge (m^3/s^{-1})	Suspended load of the river (kg/day) (Estimated)			
			Coarse grained	Medium grained	Fine grained	Total
17.7.2009	200.15	462.15	4.12	20.58	112.50	1370.20
18.7.2009	199.35	450.10	4.07	20.37	111.35	1350.80
19.7.2009	200.23	457.00	3.88	19.43	106.24	1290.56
20.7.2009	198.00	452.05	4.08	20.43	111.68	1360.20
21.7.2009	198.00	449.00	3.98	19.89	108.76	1320.63
22.7.2009	202.12	456.14	4.04	20.19	110.42	1340.66
23.7.2009	201.05	460.00	4.09	20.48	111.94	1360.52
24.7.2009	200.10	457.12	4.11	20.58	112.52	1370.23
25.7.2009	201.00	455.10	3.96	19.80	108.24	1320.00
26.7.2009	200.00	456.00	3.93	19.64	107.39	1300.96

Source: Field survey (2009).

Table 7.7 Measurement of sediment loads at 1.5 km upstream from the confluence of Rayeng River with Tista, above the residue of the bridge (Monsoon season).

Date	Cross section area (sq. m)	Discharge (m^3/s^{-1})	Suspended load of the river (kg/day) (Estimated)			
			Coarse grained	Medium grained	Fine grained	Total
17.7.2009	187.25	408.25	7.23	18.81	118.62	1440.67
18.7.2009	186.15	400.05	7.10	18.46	116.48	1420.05
19.7.2009	186.00	399.00	6.96	18.12	114.28	1390.35
20.7.2009	185.25	405.00	6.90	17.95	113.24	1380.10
21.7.2009	187.05	403.05	6.75	17.56	110.82	1350.15
22.7.2009	186.00	408.16	6.81	17.71	111.73	1360.25
23.7.2009	188.15	409.12	7.00	18.20	114.89	1400.12

24.7.2009	187.00	400.13	7.05	15.04	115.71	1410.05
25.7.2009	186.15	400.00	7.10	18.47	116.48	1420.05
26.7.2009	185.03	401.13	6.86	17.83	112.46	1370.15

Source: Field survey (2009)

Table 7.8 Measurement of sediment loads at the confluence of Rayeng River with Tista River (Non-monsoon season).

Date	Cross section area (sq. m)	Discharge (m^3/s^{-1})	Suspended load of the river (kg/day) (Estimated)			
			Coarse grained	Medium grained	Fine grained	Total
29.12.2009	32.81	30.05	3.20	14.40	142.40	160.00
30.12.2009	`32.81	29.00	3.20	14.30	141.50	150.90
31.12.2009	32.81	31.05	3.20	14.60	144.20	160.20
03.01.2010	32.81	27.05	3.00	13.40	132.60	140.90
04.01.2010	32.81	29.05	3.20	14.40	142.40	160.00
05.01.2010	32.81	31.05	3.00	13.40	132.60	140.90
06.01.2010	32.81	28.05	3.00	13.50	133.50	150.00
07.01.2010	32.81	29.05	2.90	13.20	130.30	140.65
08.01.2010	32.81	30.05	2.90	12.90	130.40	140.35
09.01.2010	32.81	31.05	3.00	13.50	133.00	140.95

Source: Field survey (2009 & 2010).

Table 7.9 Measurement of sediment loads at the confluence of Rayeng River with Tista River (Non-monsoon season).

Date	Cross section area (sq. m)	Discharge (m^3/s^{-1})	Suspended load of the river (kg/day) (Estimated)			
			Coarse grained	Medium grained	Fine grained	Total
29.12.2009	12.25	25.89	5.10	13.60	151.30	170.00
30.12.2009	12.25	24.19	5.10	13.60	150.90	160.95
31.12.2009	12.25	25.29	4.60	12.90	136.60	150.35
03.01.2010	12.25	26.82	4.40	11.20	131.20	140.75
04.01.2010	12.25	27.65	4.80	13.00	144.40	160.23
05.01.2010	12.25	25.75	4.60	12.90	136.60	150.35
06.01.2010	12.25	24.89	4.30	11.40	126.80	140.25
07.01.2010	12.25	26.70	4.30	11.50	127.50	140.33
08.01.2010	12.25	24.35	4.10	11.20	124.20	130.96
09.01.2010	12.25	25.52	4.30	11.60	129.10	140.50

Source: Field survey (2009&2010).

Discussion

The Rayeng Basin has been anguishing from a vicious cycle of soil erosions and landslides. Ever since the British occupation, the physico-cultural set up of this basin has been seriously troubled by tea plantation, widespread deforestation, shifting cultivation unscientific and unplanned usage of land, random constructional works. Such condition tends to introduce the vicious cycle of denudation. Heavy and intense rainfall has exasperating soil erosion and landslides. Frequent landslides and soil erosion in monsoon period provide huge amount of silt and clay in the Rayeng River. Therefore, high portion of the load is carried in suspension by Rayeng River and its' tributaries. Silty banks lose their cohesiveness as they become saturation at the times of high water, as long as the water level remains high hydrostatic pressure may support the bank loose or gravels tend to fall into the Rayeng River. Thus erosion is rapid and large quantities of bed loads are immediately available. This favors channels widening instead of deepening, so that shallow channels are formed, such channels may be short lived, since sandbars, gravel shoals channel bars, point bars are developed. Cross section areas of almost in every study year, denoting disturbances in transportation of sediment loads. Artificial channel diversion and construction of bridge on the Rayeng River have disturbed the natural width of the river. Residue of the bridge has seriously hindered the transporting capacity of the Rayeng River. Huge amount of silts, clays and boulders have deposited on channel bed above the residue of the bridge due to artificial obstruction. Temporary construction of Tista Lower Dam Project in the river bed near the confluence has altered the natural characteristic of the channel. Aggradations and sedimentation of Rayeng River beds triggers off a series of sequence effects. Surplus supply of sediments owing to accelerated rate of soil erosion makes the river filled to capacity and slothful, with the result sediments are deposited in the valley floor and river bed. Constant deposition of sediments in the river bed and their resultant steady rise upward bring in the changes in the river regime. Continuous aggradations of river valley causes flattening of the valley and braiding of river channel mainly in the lower hill. Rise in the river bed due to continuous siltation reduce the water accommodation capacity of river valley on the one hand, and reduce the channel gradient on the other hand. As the filling of river valley due to continuous sedimentation goes on unabated, the valley become shallower in the lower hill (Plates 7.1 & 7.2).

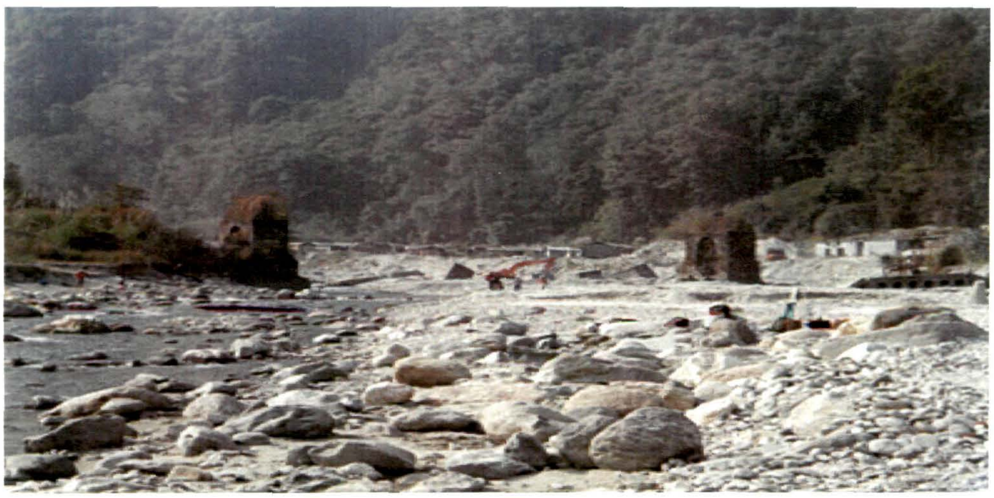

Plate 7.1 Remnant of an old bridge hindered the transporting capacity of Rayeng near the confluence.

Figure 7.2 Huge siltation in bed of Rayeng River in the lower valley part.

7.2 Deterioration of ecological balance

To determine the impact of deterioration of ecological balance it is necessary to assess the potential impact of the hazard to ecosystems associated with specific type of resource utilization of the concerned area. The term "adverse effect" has defined by Clark (1940). According to him "effects are considered adverse if environmental change or stress causes some biotic population or non-viable resource to be less safe, less healthy, less abundant, less productive, less esthetically or culturally pleasing, or if the change or stress reduces the diversity and variety of individual choice, the standard of living or the extent of sharing of life's amenities; or if change or stress tends to lower the quality of renewable resources or to impair the recycling of delectable resources". To assess the magnitude of environmental deterioration, detail information regarding the physical aspects (relief, geology, drainage, vegetation) and detailed description of the project proposal, including design plans construction methods (if any) are required. To analyze the magnitude of environmental deterioration in the Rayeng Basin, following environmental aspects have taken into consideration:

a) Alteration of natural condition such as artificial channel diversion, reduction of width of the channel for the constructional works. During the study years (2008-2011) it is observed in the field that gigantic constructional works were going on in bed of the channel of Rayeng River at the confluence of Tista River. Thus natural channel of the Rayeng was changed.

b) Disturbances in discharge hindered transporting capacity of the stream. A residue of a bridge is situated just few hundred metre away from the confluence of Rayeng River with Tista River. It is observed from the study of sediment load transportation that the residue of the bridge has disturbed the normal discharge of the river.

c) Encroachment of settlement on the vulnerable slope has removed the vegetation. Comparing the topographical maps (surveyed in 1960s) and recent satellite map of the study area it is clear that settlements in the basin have been increased in many times. For the sake of settlement large amount of vegetal cover has been removed. If we follow the state forest report (Table 7.10) it revealed that since 2004 forest area of Darjeeling District has been declining due clearance of forest for different purposes. Same scenario is observed in the Rayeng Basin in respect to the District. According to Wastelands Atlas of India, 2005, Published by the Ministry of Rural Development, Dept. of Land Resources Govt. of India and NRSA, Deptt. of Space, Govt. of India, amount of degraded forest land in Darjeeling District is 44.6 sq.km.

Table 7.10 Comparative assessment of Forest Cover in Darjeeling District from 1988 to 2006.

1988		1991		1994		1997		2000		2004		2006	
Cover (sq. km)	Cover%	Cover (sq. km)	Cover%	Cover (sq. km)	Cover%	Cover (sq. km)	Cover%	Cover (sq. km)	Cover%.	Cover (sq. km)	Cover%	Cover (sq. km)	Cover%
1609	51.11	1670	53.05	1679	53.31	1681	53.38	1681	53.38	1652	52.46	1407	44.68

Source: State Forest Report (2006 – 2007).

The steady growth of population went on building strain on the forest land for cultivation and other purposes. As a result, the forest lands countenance an invariable threat, owing to encroachment contemporarily. After the Forest (Conservation) Act, 1980 came into force the problem was, however, greatly checked. For diversion of forest land for any developmental purpose, compulsory afforestation on the land made available in lieu, has been made binding. Indeed the problem remains in the recent period also (Table 7.11).

Table 7.11 Status of encroachment of forest lands in Darjeeling District as on 31.03.2007.

Forest Division	Area under Encroachment (Ha.)
Darjeeling	42.440
Kurseong	1.520
Kalimpong (G & S)	-
Wildlife –I	63.950
Wildlife-II	34.900

Source: State Forest Report (2006 – 2007).

Different anthropogenic activities in a watershed results into deterioration in the catchments of the rivers, lastly leading to accelerated erosion, which steadily modify the productive land into barren wastelands. This land degradation poses severe confront by filling up of the river beds and sinking the life of the reservoirs and also trim downs agricultural productivity. The soil and water conservation measures are so, necessary in excellent land management and watershed planning. The dealing measures are designed to put off soil erosion, improves land capability, improve moisture regime and diversify biological bequest.

d) Forest fire is the salient reason subsequent to unlawful deforestation which does immeasurable damage to the forest area. Aside from destruction of plantations, it damages biodiversity including assassination of wild animals thereby causing habitation destruction. Even if forest fire can be natural as well as man made, but negligence of man is the cause of about 95% of the forest fires (Table 7.12). Based on the intensity, fierceness, and place of incidence of fire can be of many types. The major types seen in the District are creeping fire, ground fire and surface fire caused by local people unwittingly throughout the dry spell of the year (State Forest Report; 2006 – 2007).

Table 7.12 Forest Fire Report 2006 - 2007.

Division	No. of cases	Area affected (ha.)	Estimated loss (Rs. in lakhs)
Darjeeling	6	51.90	-
Kurseong	26	43.15	0.40
Kalimpong (G & S)	5	105.75	-
Wildlife - I	72	625.00	1.58

Source: State Forest Report (2006 – 2007).

There is a pressure on forests in this basin. In addition to socio-economic problems of poverty, underemployment and unemployment in the forest fringe areas, the foremost menace to forest comes from illegal gathering of fuel wood, fodder and small timber from the forests by the villagers to sustain their livelihood. Very high rainfall and weak rock formation lead to frequent land slip, soil erosion and gulley formation in this mountain basin. Deforestation and faulty agricultural practices has been aggravated the situation.

e) River water quality analysis shows that the river water within the valley is not good near the confluence of Rayeng with Tista and just besides the tea gardens. From the tea gardens several insecticides and pesticides are mingled with the river water and contaminating the river water. Not only residents of the nearby settlements dumped garbage with the river and contaminating the river water. Decline in the river water quality has a direct harmful impact on the health of the water user groups downstream of the Rayeng Basin. Incidents of diarrhea, typhoid, jaundice, cholera and skin diseases are of ordinary occurrence among the user groups. Though, there is no detailed survey with look upon to this. The riverside inhabitants complain of the occurrence of such diseases in the dry season when they have no option other than using the river water to meet daily demand. The polluted river water has seriously impaired the aquatic ecology and biodiversity along the Rayeng River. The contamination of surface water and groundwater pollution can result from the large scale application of fertilizers, pesticides and agrochemicals in tea garden area. Total dissolve solid, Sulphate, Sodium, pH, BOD and other parameter are more than the permissibility limit (WHO) in the tea garden area.

Table 7.13 Impact of anthropogenic activity on ecology.

Sl. No.	Major activates	Effects on environment	Affected areas
1	Artificial channel diversion	Reduction of discharge, transporting capacity, constrain in natural flow	Confluence of Rayeng river near Rambi bazar
2	Pastures	Increasing soil erosivity, removing shrubs, grasses along with destruction of microorganisms.	Sittong Khasmahal, Rolak, lonku etc.
3	Agricultural practices	Soil erosion, removal of vegetations	Toryak Khashmahal, Sittong, Selpu Khashmahal, upper Lower Mamring Khashmahal Mahak, Pubong Kashmahal, etc.
4	Plantation	Soil erosion, removal of vegetations	Mangpu
5	Construction of roads	Causing landslides	NH-31 at the Margin of Biric, Bhalukhop & Rayeng forests
6	Establishment of settlement	Removal of vegetations, increasing Shearing stress for landslide	All villages
7	Construction of bridge	Constrain natural flow by reducing width of the stream channel	Rambi bazar
8	Dumping of garbage in the river	Constrain the natural flow on the streams	Downstream of Rayeng river
9	Construction works in the river basin	Diversion of channel, constrain in natural flow	Confluence of Rayeng river
10	Use of chemical fertilizers, pesticides, insecticides in teagardens	Contaminating the stream water harmful for aquatic lives	Pudung Kashmahal

Based on assessment by the Researcher.

From the above mentioned study following facts are revealed:

1) Natural flow of the channel has been altered.
2) Vegetal communities have been reduced (plate 7.2).
3) Soil erosion and landslides have increased

4) Aquatic lives are in danger.

5) Ecological balance has been disturbed.

Measures may be suggested to restore the ecology of the basin:

1) Artificial channel diversion to be restricted.

2) Constructional works must be done up to the sustainability of the environment.

3) Removal of forest must be prohibited.

4) Pasture to be restricted on the steep slope

5) Plantation and agriculture to be limited on the soil erosion and landslide prone areas.

6) Settlement must not be built up on ecologically vulnerable areas.

Plate 7.2 Vegetal covers are reduced due to forest clearance at Lower Mamring Kashmahal.

7.3 Changes in regime condition of Rayeng River

River regime denotes the changes of flow of river in a temporal context. The significant change in flow of a river is mainly found with the change of seasons. There are various factors which control the river regime such as climate, vegetation, soil and rock structure, basin morphometry and hydraulic geometry of basin. The characteristics of the flow regime are determined not only by the climate but also by the physical and land use characteristics of the drainage basin.

1) The pathways taken by water as it travel to the channel network.

2) How the flow in a river responds to inputs of precipitation.

3) Seasonal variations in flow that characterise different climatic zones.

4) The size (magnitude) and frequency characteristics of floods.

5) Flows are significant in shaping the channel.

In the Rayeng basin these factors are modified by the anthropogenic activity. The factors influencing in the modification of regime of the Rayeng basin are discussed below:

Unequal distribution of rainfall

In this basin rainfall is highly fluctuated seasonally. More than 80% of the rainfall occurs from the month of June to August by the southwest monsoon. In the rainy season amount of discharge is many times more than the dry winter season. In the rainy season rainfall is not well distributed. Rainfall is concentrated for few days and there may have interval of the occurrences of rain. On the heavy rainydays discharge of this river is too high than the non rainydays.

Land use changes

Land use pattern of Rayeng Basin has modified the hydrological regime of the basin. Deforestation in the basin area and introduction of plantation crops in hill areas replacing the natural vegetation reduces the storage capacity of soil and resulted to surface soil erosion in the watershed and sedimentation in Rayeng River. Consequently channel becomes shallower which has altered the flow regime in Rayeng River. Deforestation, agricultural malpractices in the uplands and excessive exploitation of natural resources has increased the rate of erosion, and mass wasting and sedimentation in downstream areas posed serious and constant threats to the overall stability of river regime (Figure.7.0)

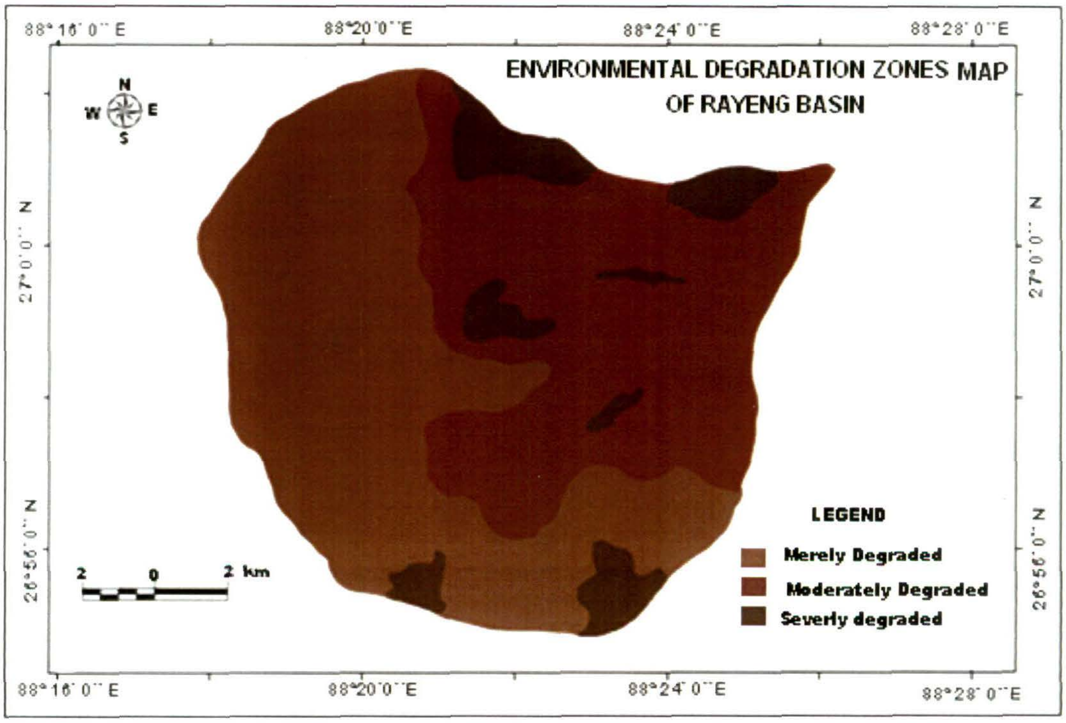

Figure 7.0 Scenario of environmental degradation.

Constructional works in the basin

Construction of bridges and artificial channel diversion at the confluence of the Rayeng River with Tista have been altered the natural flow capacity of this river. Consequently hydrological regimes have been modified (Plate 7.4 & 7.5).

Plate 7.4 Hindrance in flow regime due construction of bridge about 1.5 km away from the confluence of Rayeng.

Plate 7.5 Constructional works in the river bed at the confluence of Rayeng River with Tista River altered the character of channel.

Conclusion

From the overall study it is revealed that the ecological balance of basin has been disturbed and natural geomorphic characteristics of the river has been modified due to environmental degradation in the Rayeng basin. In sight of the knowledge and the lessons learnt from the times that the perception of basin-wide planning has been sensed indispensable for sustainable development in Rayeng Basin. Mitigation measures have to be made, founded on the current environmental conditions and study suggestions, with regard to river water pollution and short term and long term measures to curb the present rate of erosion and sedimentation are envisaged to be effective for the basin environmental management. The development of land and water resources has an unfavorable result on Rayeng River, altering flow regimes, water quality, morphology, and physical and ecological function. Direct impacts on this river channel result from bridge construction and channel diversion. Indirect impacts are brought about by activities within the basin, such as agricultural development, deforestation etc. Conventional management has paying attention on human requests, with tiny look upon for the physical, chemical and biological condition of river channels. Altered flow regimes have many unfavorable effects, such as troublemaking the timing of life-cycle events and sinking the degree and duration of flooding. Channel diversion seriously reduces the diversity of habitats within the river channel, meaning that few species can stay alive. The relations between ecosystem health and human health are increasingly acknowledged, and growing environmental concern has led to a shift in management priorities.

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