Trans. Inst. Indian Geographers
Vol. 29, No. 2, 2007

Soil Erosion Intensity Zones in Liddar Basin, Kashmir

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Abstract

Soil erosion is one of the most significant degradation processes which is not being widely perceived but gradually unfolding a serious threat to human well being. The Liddar basin with diverse physio-climatic conditions and farming systems is highly vulnerable to soil erosion hazards. More than half of the study area is subjected to high erosion with rates of soil loss ranging between 0.72 tons/ha/year to 34.5 tons/ha/year. Therefore, the present study with an objective to formulate the suitable conservational measures makes an assessment of the magnitude and extent of soil erosion hazards within the framework of four erosion intensity zones.

Introduction

Soil erosion, which has direct impact on the development of human society, is one of the important problems human beings face. It has assumed dangerous dimensions in recent years with the fast shrinking land base and declining agricultural productivity on one hand and the increasing demand for food arising from the rapid growth of population on the other hand. Thus posing a serious threat to the food security. The problem of soil erosion is found all over the world, but in developing countries like India there is the additional issue concerning the capacity of the existing land resources to provide food for the rapidly growing population. According to information published by the Ministry of Agriculture, Govt. of India in 1980, as many as 175 million hectares of land constituting 53% of India's geographical area is subjected to environmental degradation. About 150 million hectares have been caught in the vicious circle of erosion by water and wind, the vehicles of erosion. The seriousness of the problem in the state of Jammu and Kashmir is apparent from the fact that the state imports food grains from other states of the country, as only 29.13 percent of the land is cultivated. Besides lowering the food productivity the immediate consequences of soil erosion in the state are increased siltation, rise of level of rivers, reservoirs and dams followed by floods etc, all having an enormous effect on the socio-economic aspects of the state.

The Liddar basin having a catchment area of 1134 km^2 lies between 33° 45'N and 34°15'N latitudes; and between 75°E; 75° 30'E (Fig. 1). Adjacent to the basin lie the basins of Arapat Kol in the south, Sindh in the north and Harwan and Arapat basins in the northwest. The relief of the basin is quite diverse, comprising of high mountains, steep slopes, alpine pastures and alluvial fans. The high mountain ranges of the middle Himalayas contain peaks as high as 4889 metres. On the east, the mountain ranges are even higher with peaks above 5200 m

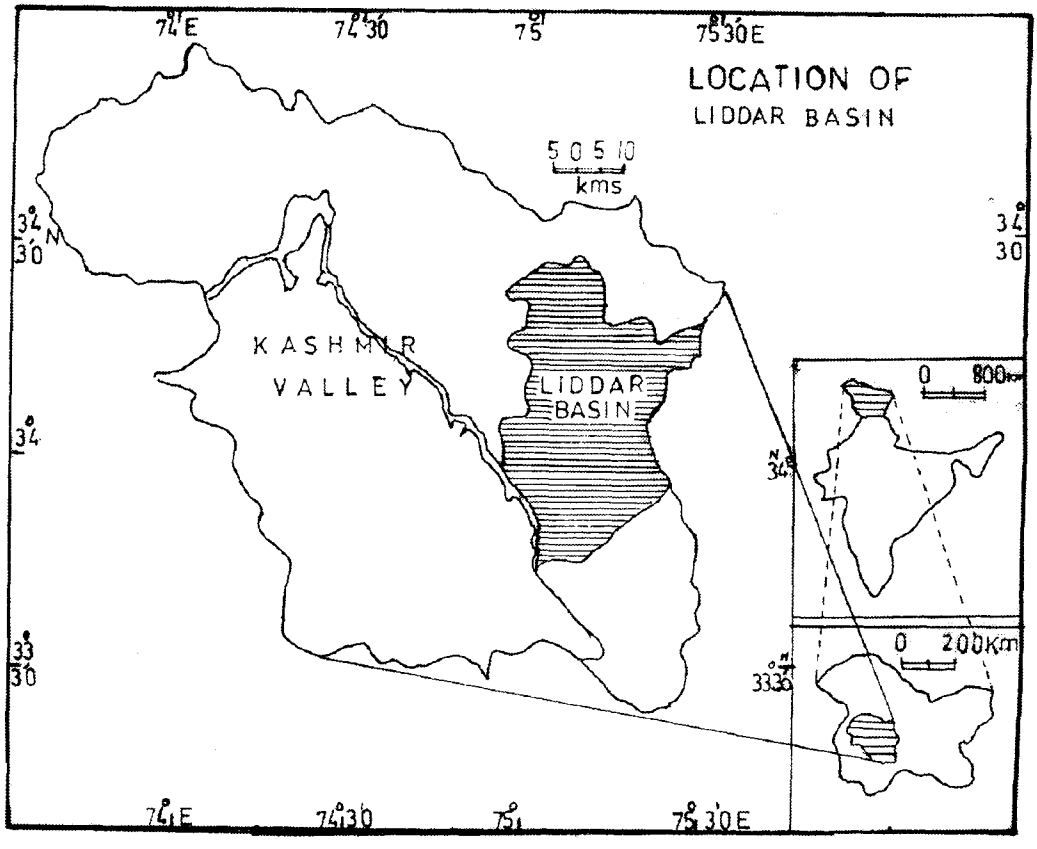

Fig. 1: **Loction of Liddar Basin**

elevation. Due to this hilly and mountainous nature of the terrain the study area is highly vulnerable to soil erosion. The problem is encountered both on agricultural as well as non- agricultural lands.

Assessing the soil erosion hazard in the Liddar basin is a complex problem because of its diverse physiographic and climate conditions. The erosional hazards in the study area are largely the outcome of the interaction of various factors viz. climate, relief, erodibility, deforestation and land use practices.

Climate

The general climatic conditions throughout the valley of Kashmir are similar with roughly the same seasonal rhythms, of monsoon climate. Regarding the climatic erosivity, the valley receives a fair amount (754 mm mean annual rainfall) of precipitation both in the form of snow and rainfall. However, there are essential differences in the daily weather conditions of the Jhelum valley floor and the side valleys. These weather differences are brought about by the combined effects of altitude and the presence of mountains in the close vicinity of the side valleys, The temperature of the study area is

several degrees lower than that of Srinagar and Anantnag during summer months. Similarly the number of rainy days as well as the amount of rainfall is higher in Liddar basin compared to Anantnag and Kulgam.

Relief

The relief aspect in view of erosion have been measured by two parameters altitude and slope characteristics of the Liddar basin. These two parameters in general indicate the relief differences between various regions

Altitude

The relief of the basin is diverse comprising of high mountains, steep slopes, alpine pastures and meadows (*margs*) and alluvial fans. These diverse conditions of relief play an outstanding role in inducing soil erosion processes in the Liddar basin, as there is a regular increase in altitude almost in all directions from the flood plain belt to the surrounding uplands and mountains. The average altitude of the flood plain belt ranges from 1500 to 1900 metres and is comprised of flat topography characterised by aggradational features. The bordering Kerawas and sloping uplands with an average altitude ranging between 1900 to 2400 metres are dominated by erosional topography. The mountain ranges comprising of rocky slopes, glacial zones, hillocks and dissected uplands from all the sides produce a variety of slopes through their descent to the valley floor, thus producing ideal conditions for erosion by sub-areal agent of denudation.

Slope

Representation and analysis of slope is of great significance in the study area, because the degree of slope controls the amount of runoff, velocity of river as well as the processes of erosion, transportation and deposition. Among the slope factors, slope gradient is an important factor governing the efficiency of splash erosion and also influencing soil erosion through its impact on physical and chemical properties of soils, land use and possibilities of irrigation. The Liddar basin presents varied slope characteristics from gentle to undulating high steep slopes. They have been divided into five major slope categories. However, for the purpose of the present study, these five categories of slope have been condensed into the following four slope regions.

i) ***Regions of level gentle slope***, which consists of low lying plains and adjacent terraces having a slope varying between 0°-10°.

ii) ***Region of moderate slope*** – consisting of lower foothills, flat-topped Kerawas having a slope varying between 100 and 20°.

iii) ***Region of moderately steep slope*** – consisting of sloping Kerawas, forest slopes and alpine pastures and with a slope varying between 20°-30°.

iv) ***Region of very steep slope and escarpments*** with a slope of more than 30° covering rocky slopes and glacial zones.

Erodibility

The soils of the study area show some variations in their physical and chemical properties leading to various differences in their erodibility status. The soils of the Liddar have been divided into four major groups in terms of erodibility i.e., flood plain soils, kerawa soils, mountain soils and miscellaneous lands. The soils rich in clay are more

resistant to erosion as compared to the soils that are poor in clay content.

Erosion problems vary according to the land use practices. In Kashmir Valley 29.13 percent of the land is cultivated out of the total land out of which 13 percent is irrigated, and 13.12 percent of total area is under pastures.

Assuming that the irrigated area and permanent pastures which together constitute 16.12 percent of the total area is well protected and has no soil erosion problems, the remaining 82.88 percent of land area is facing one or the other land degradation problem.

Deforestation

In the Liddar basin most of the forested area has been converted into the areas of cultivation and habitation, therefore, not only resulting in the general degradation but also physical shrinkage of areas under forests. An important factor leading to the deterioration of land in the study area is the over-grazing of pasturelands and forests. Thus this severely increased the erosional problems by depleting the top cover of the soils which leads to excessive runoff. Another burden on the forests is excessive fuel wood consumption. In most of the villages the demand for fuel is met by fuel wood from nearby forests.

On the basis of these factors and other numerous observations an estimate of the magnitude and extent of soil erosion hazards in the Liddar basin is possible within the framework of four erosion intensity zones whose spatial distribution is shown in Fig. 2. The relationship of these four erosion intensity zones with other physical factors is given in Table I. The rate of soil erosion for the four erosion intensity zones has been computed with the help of the Universal Soil Loss Equation USLE (Wischmeier and Smith, 1965; Fournier, 1972). The USLE equation is given below.

$$Pa = R \times K \times LS \times C \times P$$

Where

Pa = the potential soil loss per unit.

R = the erosivity factor of area.

K = the soil erodibility factor.

LS = the topographical factor.

C = the cropping management factor.

P = the erosion control practice factor.

The four erosion intensity zones are as follows:

i) None to slight erosion intensity (the valley bottom and the adjoining paddy zone).

ii) Slight erosion intensity (flat topped Kerawas and side valleys).

iii) Slight to moderate erosion intensity (sloping Kerawas and alpine pastures).

iv) Moderate to severe erosion intensity (steep high hill slopes).

Zone I

This zone consists of flood plains and adjoining paddy growing zone. The intensity of erosion in this zone is very low with rates of erosion less than 0.72 tons/ha/year. The low intensity of erosion is because of its levelled topography with slope gradients ranging between 0° to 10° and an average altitude ranging between 1500-1900 metres. The soils of this zone, which are alluvial in origin, have a rich content of organic matter due to which the erodibility of soils is of lower order. The

slopes in the adjoining paddy growing zone are well managed and successfully terraced and put to cultivation, thereby ruling out erosional problems. However, slopes facing the rive beds are subjected to some erosional problems especially during heavy rainfall and floods. This zone is predominantly put to paddy cultivation. However, a considerable portion of the upper part of this zone is devoted to dry farming with maize as the dominant crop.

This zone covers an area of 160 km^2 (14.16%) and is mainly confined to 79 villages of Tehsil Pahalgam, Anantnag and Bijibehara such as Batpora, Hugam, Nowbug, Anzwalla, Mirgund, Hutigam, Yanier, Salar Malikgund, Bedigam etc. Out of the total land area nearly 16000 hectares available in this zone 1941.74 hectares about 75% are cultivated. This is because of low relief gradient, fertile soil and abundant water available for irrigation.

Zone II

This zone acts as a transitional zone between low lying plains and the hills with intermingling of the land use characteristics. While a good proportion of area is under crops, an equally sizeable area is used for grazing lands. This zone comprises of the lower foothills, sloping Kerawas and side valleys of numerous streams with an altitude ranging between 1900-2400 metres and slope gradients varying from 10° to 20°. The intensity of erosion in this zone is low with rates of erosion varying between 0.72 tons/ha/year to 1.54 tones/ha/year. This is mainly due to the sloping nature of the terrain which varies between 10° to 20°.

This zone covers an area of 142 km^2 (12.52%) and includes 26 villages of Tehsil Pahalgam such as Botkote, Lidroo, Shumhal, Hassan Noor, Laripora, Wajipora and Chatruss Budroo etc. The proportion of the cultivated land to the total land decreases rapidly in the higher slope categories. Out of 14,200 hectares available only 2624.04 hectares (18.47%) are cultivated.

Zone III

This zone forms a linear belt all along zone II consisting of forested slopes of Lagipur, Laginala, Dabyum and Kolar forests and alpine pasturelands with an average altitude ranging between 2400-3200 metres. The soils of this zone experience moderate erosional problems with rates of erosion varying between 1.54 tons/ha/year to 10.5 tons/ha/year as there soils occur in moderate to moderately steep hill slope which varies between 20°-30°. The low- lying slopes within this zone are thinly covered forests and the Kerawas are devoid of any vegetal cover except some patches of grass. The common processes of erosion in this zone are sheet and gully erosion.

This zone covers an area of 198 km^2 (17.46%) is under 10 villages of Tehsil Pahalgam namely Hangul Pahoo, Awoora, Kullar, Sofipura, Lehandajan and Wularhama etc. Out of 57,400 hectares available, only 293.98 hectares, about 1.48%, are cultivated. This is mainly due to the sloping terrain, coarse texture, improper drainage and poor organic matter content of soils.

Zone IV

This zone is characterised by upper parts of the relief, hilly areas, dissected uplands and glacial zones. This zone is devoid of any vegetation cover with an average slope angle of over 30°. The intensity of erosion in this

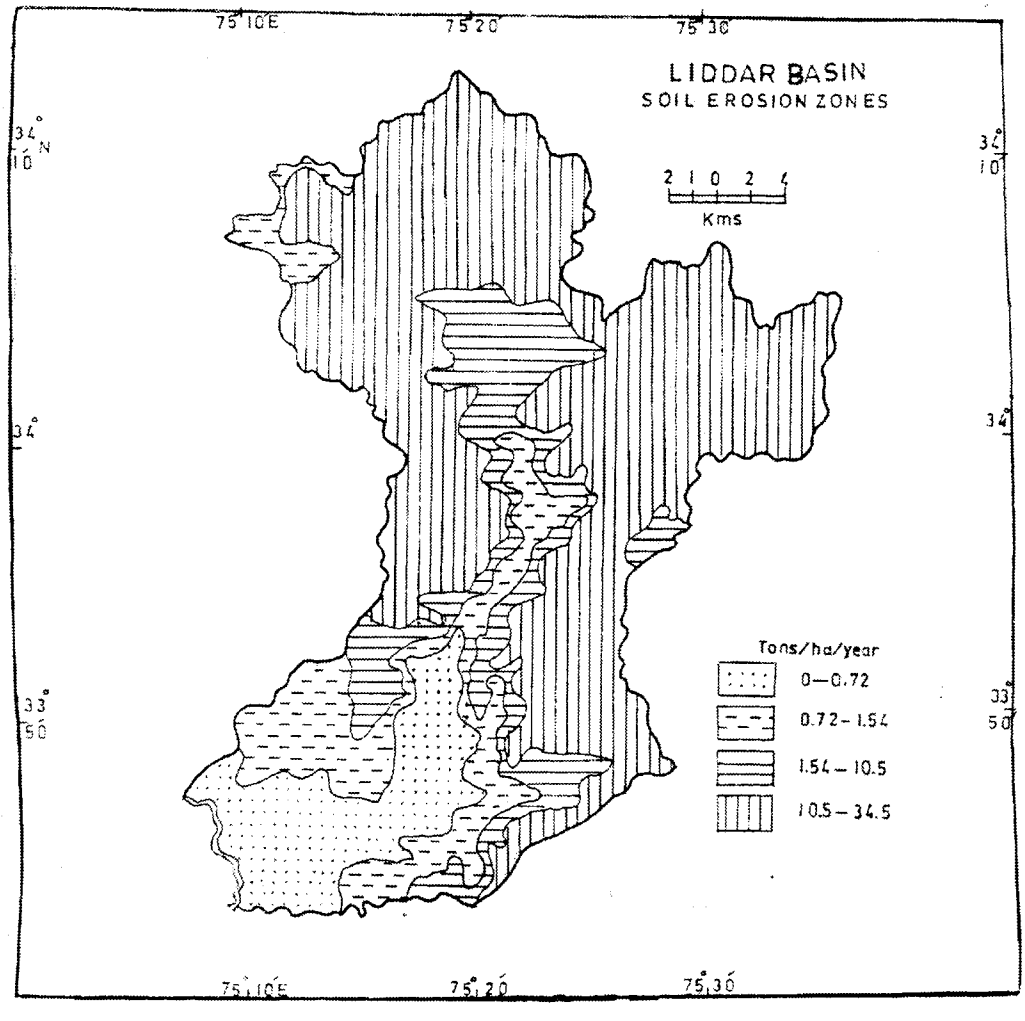

Fig. 2: **Liddar Basin – Soil Erosion Zones**

zone is high with rates of erosion varying between 10.5 tons/ha/year to 34.5 tons/ha/year. The relief of this zone is diverse comprising of the high mountain ranges of the middle Himalayas. The soils of this zone occurring on steep slopes cannot support the growth of vegetation with the result that no cultivation is done nor forests are found there.

This zone covers an area of 6314 km^2 of the study area out of which 33.99 hectares of land is available for cultivation which amounts to 0.05%. It is mainly because of the slope which is too steep to be put to any productive use.

Conclusion

The above discussion reveals that more than (55.92%) of the Liddar basin experiences extremely high rates of erosion varying between 10.5 tons/ha/year to 34.5 tons/ha/year.

Table I: **Extent and magnitude of erosion hazard and relationship of erosion intensity zones with other physical factors**

Erosion Intensity Zone	Topographical Zone	Soils	Range of slope in degrees	Range of slope in altitude in metres
Zone I	Flood plain and adjacent paddy belt	Flood plain soils	0-10	1500-1900
Zone II	Flat topped Kerawas and side valleys	Kerawa soils	10-20	1900-2400
Zone III	Slopping Kerawas, forested land and Alpine pastures	Mountain soils	20-30	2400-3200
Zone IV	Hilly Area and Glacial zone	Mountain and miscellaneous lands	Above 30	Above 3200

Table I: **Part II - Continue**

Major land use pattern	Intensity of Erosion tons/ha/year	Rates of erosion	% of Net Area	Net Area in Km^2
Paddy cultivation	None to slight	0.72	160	14.10
Dry Farming	Slight	0.72-1.54	142	12.52
Dry farming grass and trees	Slight to moderate	1.54-10.5	198	17.46
No cultivation	Moderate to severe	10.5-34.5	634	55.92

* Rates of soil loss computed by universal soil loss equation – USLE

The assessment of the magnitude of soil erosion hazards has been evaluated within the framework of four erosion zones. Zone I covers 14.10% of the study area consisting of flood plains and adjoining paddy areas of the basin. This zone faces none to slight erosion problems with the rates of erosion less than 0.72 tons/ha/year. Zone II covering an area of 12.52% of the total area includes flat-topped Kerawas and side valleys having undulating topography. The rates of soil erosion in this zone vary between 0.72 tons/ha/year to 1.54 tons/ha/year to 10.5 tons/ha/year. Zone III (17.46% of the area)

comprises of sloping Kerawas, forested lands and alpine pastures. The rate of erosion varies between 1.54 tons/ha/year to 10.5 tons/ha/year. The zone fourth which comprises of steep high hill slopes faces very severe erosional problems with rates of erosion varying between 10.5 tons/ha/year to 34.5 tons/ha/year. This zone covers the largest area, i.e. 55.92% of the total area of the basin.

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