

TITLE OF THE PAPER: STUDY OF ALLUVIAL AND TALUS FANS IN  
HIMALAYA BY REMOTE SENSING TECHNIQUES

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#### ABSTRACT

Alluvial and talus fan deposits are quite widespread and are generally coalescing in nature covering linear zones almost parallel to the Lesser Himalayan ranges.

These zones have been identified and mapped with the help of landsat imageries and aerial photographs. They appear to spread outwardly from the escarpments often with divergent drainages.

Based on the degree of their dissection, the fans seems to be chronologically younger successively towards the outer parts of the Himalaya.

#### INTRODUCTION

These studies were carried out in a part of the Garhwal Himalaya, drained by the rivers, Ganga, Nayar, Ramganga, etc. (Latitude  $29^{\circ}50'$  to  $30^{\circ}40'$  N and Longitude  $78^{\circ}20'$  to  $79^{\circ}00'$  E).

This area is rapidly being denuded by the various processes of mass-wastings, because of considerably high rainfall and paucity of the vegetative cover, and perhaps also because of the recent tectonic activities, and the presence of crushed and fractured rocks. The consequence of all these large-scale masswastings, is the accumulations of huge talus and alluvial fans, in front of escarpments, occasionally located along the river valleys.

The present paper attempts to identify and map such accumulations, and to work out their relative chronology. For this purpose, help has been taken from the aerial photographs and landsat imageries, as large areas are involved. Moreover, such features are better identified on aerial photographs than in the field.

GEOLOGICAL AND PHYSIOGRAPHICAL CONDITIONS: Physiographically, the area may be divided into two: The southern part corresponds to the outer Himalaya or Siwalik belt, whereas the northern part constitutes the Lesser Himalaya. The southern part contains, the deeply dissected Siwalik hills and their extensive alluvial plains. The northern part has a very rugged topography, with numerous stream systems, steep slopes and escarpments with a less dense vegetative cover than the southern part (Kharakwal 1977). Following

Penck's (1973) classification, the northern and southern parts of this area, may be considered to be corresponding to the phreatic and sub-phreatic zones respectively. The northern part receive a considerable precipitation, with significant fluvial action, and landslides, having deep canyons, high escarpments, alongwith the accumulations of valley side colluvium. On the other hand, the southern part is characterised by a relatively higher precipitation, with extensive alluvial and colluvial accumulations (Prasad 1982).

Geologically, this area may be divided into three broad zones, each of which is separated by a major thrust zone. The southern part of this area is occupied by the Siwalik belt; fringed by the recent alluvial plains. The Krol belt occupies the central portion, separated from the Siwalik by the main boundary thrust, whereas, in the northern part, rocks of the Chail group or Kumaon super-group are exposed (Kumar, Prakash and Singh 1974, Fuchs and Sinha 1978).

These broad geological divisions are depicted in figure 1.

The thrust zones, that separate the three divisions are main boundary thrust, and the Garhwal thrust. These zones run in a general NW-SE direction, viz. parallel to the general trend of Himalaya. The major rivers of this area, viz. Ganga, Ramganga and Nayar, cut across these thrusts, but at some places, their courses appear to have been affected by these.

The following table-I gives geological and physiographical conditions of this area.

Table - 1 Physiography and Geology

Physiographic divisions	Geological formations	Broad lithology	Terrain characters	Rainfall and vegetation	Accumulations
Southern	Siwalik group	Sandstones and shales conglomerates	Low lying hills of gullies, cuestas, hogbacks	Higher rain fall and thicker vegetation	Coalescing alluvial fans, tectonic valley filling
Northern	Krol & Chails (Kumaun super group)	Phyllites, schists, quartzites and limestones	High relief, rugged escarpments and canyons	Relatively low rainfall, timber vegetation	Valley side colluvium talus fans

METHOD OF STUDY: This study is based upon observations taken from the aerial photographs, and the corresponding Survey of India topographic maps. These observations were later checked in the field. The alluvial and talus fans were identified and delineated, on the basis of their relatively lighter tones and the presence of divergent channels generally of braided nature.

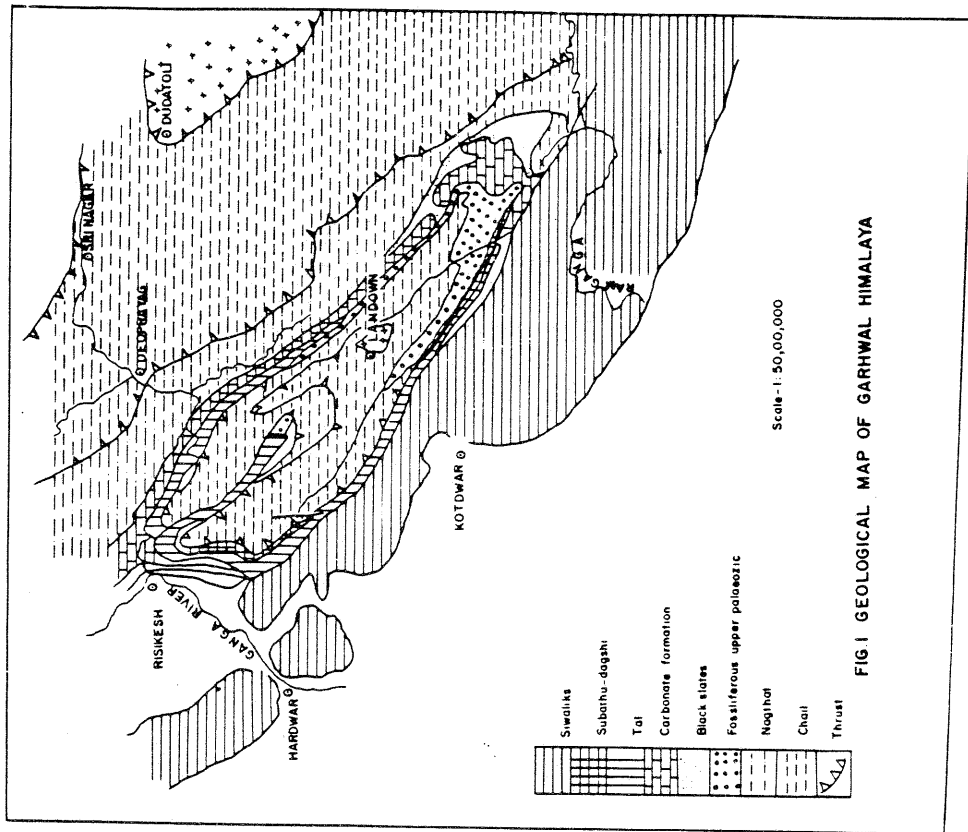


FIG. 1 GEOLOGICAL MAP OF GARHWAL HIMALAYA

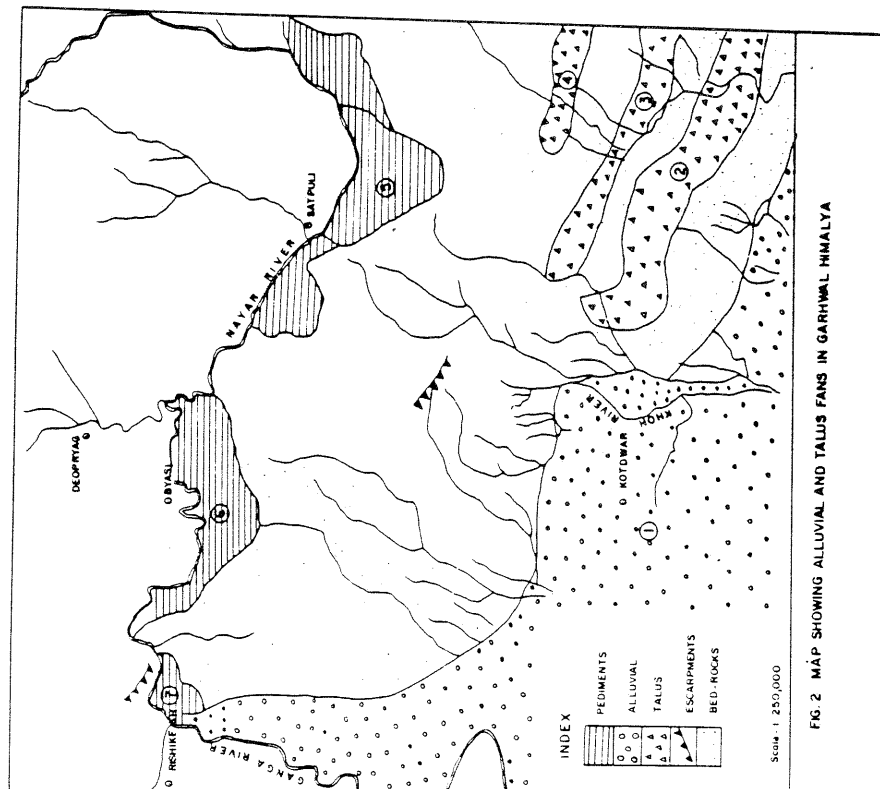


FIG. 2 MAP SHOWING ALLUVIAL AND TALUS FANS IN GARHWAL HIMALAYA

This identification was easier in the southern part of the area, because of less rugged topography, whereas this job was quite difficult in the more rugged northern part. Therefore, in such areas, the escarpments and pediments were identified as most of the talus accumulations exist in front of these features. The escarpments are zones of abrupt steepness of the slopes, whereas the rock-pediments are broad concave profiles, adjacent to the river channels (Raju and Vaidyanathan 1978).

In this way a map (fig. 2) was prepared showing the distribution of alluvial and talus fans, escarpments and rock-pediments.

Alluvial and talus fans generally coalesce to form alluvial and colluvial plains respectively, whereas, the rock-pediments also combine to form pediplains. All such features have a relatively low relief and divergent patterns of the channels.

The alluvial fans generally terminate as lob-shaped zones and the streams passing through them develop braiding (Allen 1977). On the other hand, the talus accumulations are generally cone-shaped, that are usually modified, on the erosion of their toe, and are associated with tongue-shaped rock-glaciers, and the more linear rock-streams (Watkins, Bottino and Morisawa 1975).

OBSERVATIONS: The studies indicate the presence of a large alluvial plain in the immediate south of the Siwalik belt, in the south-western part of this area, lying between Rishikesh and Kotdwara, with braided channels of Ganga and Kho rivers passing through it.

Plain 1 appears to be sloping gently towards south, with a low relief. A number of smaller streams, that enter the plain from north, appear to vanish, probably because of their going underground. This plain appear to terminate against the Siwalik ranges, towards north-west and east.

In the south-eastern part of this area, viz. north-east of Kotdwara, there appear to be three zones of smaller alluvial or colluvial plains, sandwiched between parallel and low-lying Siwalik ranges. These plains appear to have been somewhat dissected by the tributaries of the Ramganga and Kho rivers. The channels do show appreciable braiding, but nowhere the channels disappear. A significant escarpment is visible on the northern side of the northern most plain viz. no.4, and this appear to have a southward slope. It appears that the plain 4 may be a colluvial, composed of coalescing talus fans. On the other hand the plains 2 and 3 may be tectonic - valley in-fillings, accumulated in the depressions between the parallel ranges of Siwaliks (Raju 1967).

The escarpment located at the head of plain 4, trends roughly in an East-West direction and may correspond to the Main Boundary Thrust, that separates the Siwalik belt from the Lesser Himalaya.

No. 5 is another talus fan occupying a pediplain located south of the Eastern Nayar river No.6 is another talus, attached to yet another pediplain south of the Ganga valley near Byasi. Similarly no. 7 may

be another fan related to a pediplain. On closer examination, no.5, appears to be a colluvial plain, formed by three coalescing talus fans, with their fan-heads lying towards south on the edge of the pediplain. From these fan-heads a number of lobate rock-glaciers emerge, which appear to have deflected the course of the Eastern Nayar, at several points giving it an appreciable sinuosity.

Nos. 6 and 7 appear to be parts of a single colluvial plain, detached by erosion. No. 6 also appears to be a combination of atleast three talus fans, with their fan-heads lying southwards. This plain also appear to be full of lobate rock-glaciers that have been responsible for diverting the channel of Ganga. In the same way, no. 7 may be one single talus fan. These plains viz. numbers 5, 6 and 7 show a considerable slope towards north, the angle may be around  $30^{\circ}$ , which is the angle of repose.

The following table gives the morphological characters of these zones of alluvial and talus fans.

Table II - Morphological characters of alluvial and talus fans.

No. and location	Nature of plain	General inclination and direction	Maximum width (kms)	Relative degree of dissection
1. South-west of the area	Alluvial	$3^{\circ}$ - $5^{\circ}$ towards south	-	very little
2 & 3 Ramganga valley	Tectonic valley fillings	$5^{\circ}$ - $10^{\circ}$ southwards	0.84 and 0.64 respectively	more than no.1
4. Ramganga valley	number of talus fans	$25^{\circ}$ towards south	0.58	considerable
5. Nayar valley	Talus fans	$25^{\circ}$ - $30^{\circ}$ northwards	1.20	considerably dissected
6 & 7 Ganga valley	Talus fans	$25^{\circ}$ - $30^{\circ}$	1.30	considerably dissected

INFERENCES: Considering the geological and climatic settings, the above features may be grouped into two. The Siwalik rocks are located in the southern part of this area, which receives a relatively higher rainfall, whereas the northern part of this area is occupied by the metasediments belonging to Lesser Himalaya, with a lower precipitation, but higher relief and ruggedness (Prasad 1982). As the evolution of alluvial and talus fans are controlled by the lithology of the bedrocks and the extent of precipitation (Reineck and Singh 1973), these fans

may also be classified similarly. Therefore, fans (1, 2, 3 and 4) and (5, 6 and 7) may be considered in different contexts.

Among the fans belonging to the Siwalik belt, no.1 appear to be the youngest with maximum area and width, very little dissection and a lower angle of slope. The zones 2, 3 and 4 appear to be successively older, with their increasing slopes and relief. The oldest zone possesses a minimum width probably because of denudation.

The conditions appear to be quite different in the cases of zones 5, 6 and 7. The presence of rock glaciers and rock-streams in them show that these are being modified even today with more and more erosion at their fan-heads and are growing outwardly. The zone 6 appears to be relatively young as it possesses a greater width, and is located more outwardly within the Lesser Himalaya, nearer to the Siwalik belt. This zone is growing with more and more additions of sediments (Allen 1977).

#### CONCLUSIONS

Based upon the above observations, following conclusions may be arrived at -

- i) The zones of alluvial and talus fans may broadly be classified into two viz. one belonging to the Siwalik zone in the southern part of this area, and the other to the Lesser Himalayan zone in the northern part of this area.
- ii) The zone no. 1 is the youngest, located south of the Siwalik zone and may be part of the U.P. plains.
- iii) The zones belonging to the Siwalik belt become successively older northwards, as indicated by their decreasing widths and increasing slope, relief and degree of dissection.
- iv) The zones belonging to the Lesser Himalaya are related to the pediplains. The zone that is located nearer to the Siwalik belt, with more active rock glaciers and streams and a greater width may be younger, belonging a relatively young pediplain.

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