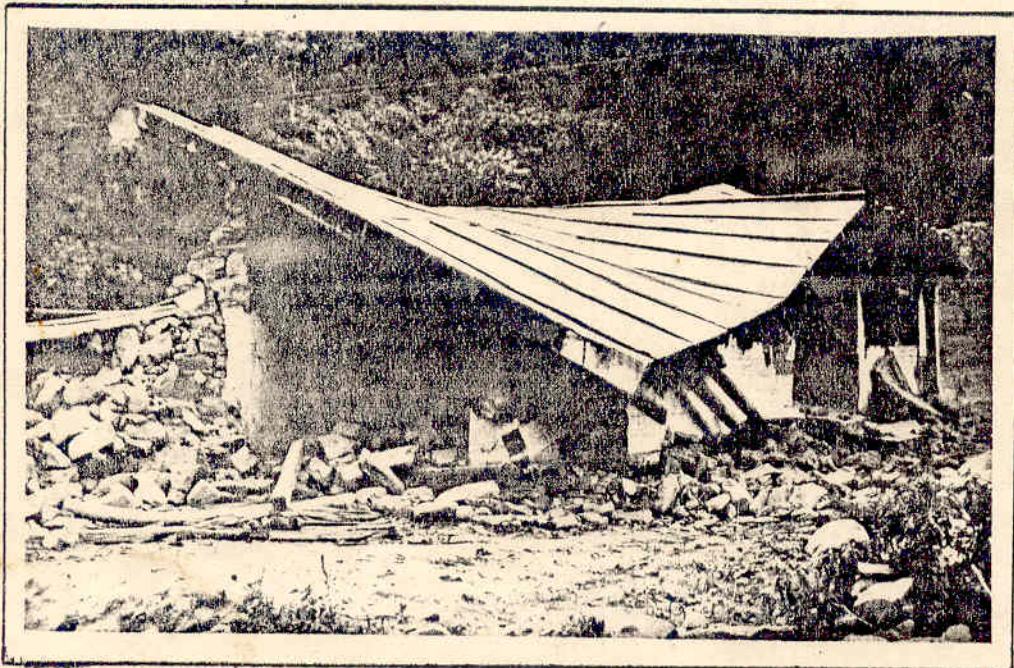


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55 Seconds That Shook Garhwal  
- A Reconnaissance Survey Report -



November 1, 1991.

APPENDIX

No report on the Garhwal earthquake can be complete without a reference to the Tehri Dam.

We did not survey the dam site. But all along the valley, we could not help noticing the fragility of the mountain slopes (see picture 9a). At Sanglai, debris falling into the river had almost totally obstructed its flow (picture 9b). Thus, in a major earthquake, even if we accept for a moment, that the dam will withstand the shock, what will protect these fragile slopes from tumbling into the reservoir?

We were also struck by the active support being provided by the main contractor Jaiprakash Associates to the official teams of scientists. Another remarkable feature was the quick release of the compensation for the dead in Tehri-Garhwal, but not in the worst-hit areas of Uttarakashi. Was there a political motive here?



55 SECONDS THAT SHOOK GARHWAL

## A Reconnaissance Report

On October 20, 1991 an earthquake struck the Garhwal region at 2:53 am for 55 seconds. The quake's epicentre was located at Agora village in Uttarakashi district (see Map). The earthquake was of moderate intensity, measuring 6.2 on the Richter scale. The consequent destruction appears to be confined to the districts of Uttarakashi, Tehri-Garhwal and Chamoli.

\*  
A team of scientists from People's Science Institute (PSI) undertook a reconnaissance survey from October 27th to 29th. The area surveyed is shown in the Map and the villages visited are listed in Table 1. The team reached Burha Kedar on October 27th. They held discussions with the staff of Lok Jivan Vikas Bharati, a Sarvodaya organization (Secy: Shri Biharilalji) in Burha Kedar. The LJVB staff assisted the PSI team in their survey of the surrounding villages. The next two days were spent in the worst-hit region of Uttarakashi district.

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\* The team included:

D.K. MISHRA : Disaster Assessment & Relief Consultant.  
RAJESH KUMAR : Research Scientist (Water Resources &  
Agriculture), PSI.  
A. PANDHI : Research Assistant, PSI.  
A. RAVINDRA : Research Scientist (Economics), PSI.

The basic objectives of the survey were:

1. To qualitatively assess the impact of the earthquake with a special focus on agriculture and water resources.
2. To review the coping efforts including the relief assistance.
3. To identify PSI's role in rehabilitation programmes.

The survey report follows.

### DISASTER ASSESSMENT

The Garhwal earthquake's impact is quite different from that of the Bihar earthquake in 1938. Though it was of a moderate intensity, its impact was magnified by the geography of this Himalayan region. In fact, the onset of the winter season and the local ecology will intensify both the medium-term and long-term impact.

As expected, the intensity of the destruction varied inversely with the distance from the epicentre. In the region of Uttarakashi visited by PSI, the destruction was massive. Deaths of human beings and livestock resulted almost exclusively from house collapses, while infrastructural damage -- roads, terraced fields, power lines resulted mainly from landslides (Pictures 1a and 1b).

In the Tehri Garhwal region visited, by contrast, the damage was localized and essentially due to house collapses. A qualitative picture of the nature and extent of the damage emerges from Table 1.



In addition to the loss of life -- both human and livestock, and injuries, the major elements of the devastation are:

### Destruction Of Houses

Collapse of houses was the main cause of deaths -- human and livestock, in both Uttarakashi and Tehri Garhwal.

In the surveyed area of Uttarakashi, most houses had either collapsed or were seriously damaged. In Kalyani and Sanglai villages, the destruction was total (Picture 2a). The same appeared to be the case in Agora, the epicentre of the earthquake. In these villages, even the newer concrete structures had collapsed.

In the surveyed region of Tehri-Garhwal, more houses had been damaged than destroyed. Houses with stone walls were more prone to collapsing. Deaths also resulted where slate roofs had caved in. While the newer concrete structures appeared undamaged, older ones had developed serious cracks (Picture 2b). Most of the structures that had collapsed, belonged to the poorer Harijan families. In Kot, a Harijan village near Burha Kedar, the destruction was complete. Nearly 50 to 55 houses had collapsed and six people had been killed.

It appears, therefore, that the death toll is almost entirely due to the use of inappropriate building materials, particularly slate roofs. Pointing to a collapsed structure, a villager in Sanglai said, "We have been killed by such big houses. A tin roof would have been better." With wood becoming

a scarce resource, older quake-proof technologies like the 'Dhajji-diwar' have disappeared. In rehabilitation programmes, it will be important to emphasize the use of lighter and locally available materials. The state Government should be asked to provide biomass resources from forests for housing rehabilitation.

### Landslides

Major landslides due to the earthquake, become continuously visible when moving beyond Uttarakashi town into Bhatwari tehsil and beyond (Picture 3a). Roads appeared to be both a cause and the victims of landslides. In contrast, trees appeared to have arrested the damage at several places.

The collapse of the Uttarakashi -- Maneri link bridge (see Picture 1a) forced the team to take a detour from Gangori to Agora, the quake's epicentre. Extensive damage was visible along this road. After the village of Rawar (2km from Gangori) the road was blocked by continuous landslides. The team trekked another 4km to Kalyani. Here the road was blocked at many places by massive boulders (usually limestone) -- Picture 3b. Even trekking beyond this point was difficult, though people could be seen doing it.

An interesting feature of the stretch from Gangori to Kalyani was that at several sites, trees seemed to have withstood the landslides and at places even arrested them (see Picture 4a). Landslides were almost continuous along the slopes where the road had been constructed. These observations bring to the fore the



debate on the extent and nature of road construction in the hills.

A related problem is the appearance of deep cracks in the hillslopes. It is feared that with the onset of rains and the freezing cold during winter, there will be renewed weathering and destabilization of the hillslopes. Villagers in Burha Kedar (Tehri-Garhwal) talked of three major cracks with reported lengths of 2 to 12 kms. The acute apprehension of the local population was evident in the words of people from Sanglai village (Uttarakashi), "The ground here is such that once water enters it, the (mountains) will be washed away. Our first demand before the government is that we should be resettled in the plains." The likely impact of these cracks, therefore, needs to be assessed on a priority basis.

The destabilization of the hillslopes due to the earthquake was visible throughout the tour of Uttarakashi in the form of continuing rockslides and landslides (see Picture 4b), during the tour period.

#### Agricultural Impact

The earthquake appears to have affected agricultural fields and production mainly in Uttarakashi. The kharif crop had been harvested in Tehri-Garhwal before the earthquake. Rock and landslides in Uttarakashi had damaged terraced fields and the crops standing on them in several villages (see Pictures 5a, 5b). The irrigated (paddy) crop had been harvested already. It is mainly the coarse cereale crops, meant for personal consumption

that has been affected. The damage, however, is not very major. In Sanglai village, the damage to crops was significant.

Pucca gulis (concrete water channels) the main form of irrigation, appear to have withstood the earthquake in most villages.

The existence of cracks in the hillslopes and the coming winter season continues to pose a threat to the agricultural fields. This aspect too needs further investigation.

### Livestock

The loss of livestock has been ignored in newspaper reports. But the loss may be significant in Uttarakashi.

In the hills, livestock (mainly cattle) are penned at night. The extensive collapse of shelters in Uttarakashi has in all probability taken a high toll of livestock. The approach to many villages here, was marked by the stench of rotting corpses or carcasses lying by the roadside (see Pictures 6a, 6b). According to the villagers, human bodies had been pulled out of the debris already. Till the livestock carcasses are pulled out of the debris, it will be difficult to make an assessment of the loss of livestock.

### Women: An Unsurveyed Group

It is well-known that in many parts of the hills, male members of families migrate to the plains in search of jobs. Hence, the proportion of resident women in the villages is often



higher. The proportion of female-headed households may also be relatively higher. This may lead to relatively higher loss of life or injuries among women (see Picture on the back cover). In Kot village, for example, out of the six deaths, five were females.

The PSI reconnaissance team being all-male had difficulty in conversing extensively with women. In the surveys that are to be carried out, it will be necessary to include women in the teams, particularly Garhwali-speaking ones.

## II. RELIEF

In any disaster situation, relief is first provided by the survivors in the affected area. It was so in Garhwal too. The coping strategies were visible when the survey team reached the affected areas.

Where the houses had collapsed, people had set up make-shift structures and were camping in the open fields (Pictures 7a and 7b). These people are most vulnerable to the severe cold at night, since in many valleys the wind-chill factor is severe. Night-time temperatures have already dipped to 10 degree Centigrade or lower.

Most of the human dead bodies had been removed. While ambulance teams were active, in some areas the injured had to trek to the medical centres for treatment (Picture 7b).

There is some sense of trauma as evidenced by the evacuation of some of the villages. Kalyani village, for example, was totally empty. In other places, people expressed fears of landslides in the winter months due to the cracks in the ground. For those camping in the open, there was some fear of attacks from wild animals.

Relief materials were flowing into the region, mostly brought in by non-government bodies or individuals (Picture 8a). The relief supplies included clothes, blankets and tarpaulins. The State administration was already providing rations. The main problem was in reaching villages at higher altitudes. Most of the organizations bringing in supplies are distributing them on the roadside, for want of personnel to reach the high-altitude villages. The ruling party and its various front organizations seemed to be overcoming this problem.

### Government Inputs

These include:

- (i) Compensation for death: The Government has announced a grant of Rs 20,000 to next-of-kin. In Burha Kedar area, in all the villages surveyed, people reported receiving the first installment of Rs 10,000. In Uttarakashi, none of the villages visited reported receiving any compensation for the dead.
- (ii) Housing Damage: An announcement has been made of varying grants depending on the extent of damage and the type of construction. This compensation has not been received by the villagers so far. Twenty tarpaulin sheets (12ft x 18ft) per Gram Sabha, approximately 10 per village, have been provided so far in Uttarakashi (Picture 8b).
- (iii) Ad Hoc Grants: Ad hoc grants of Rs 500 per family have been given in Uttarakashi district.



- (iv) Rations: Ten kg of atta and kerosene per family have been provided to roadside villages in Uttarakashi.

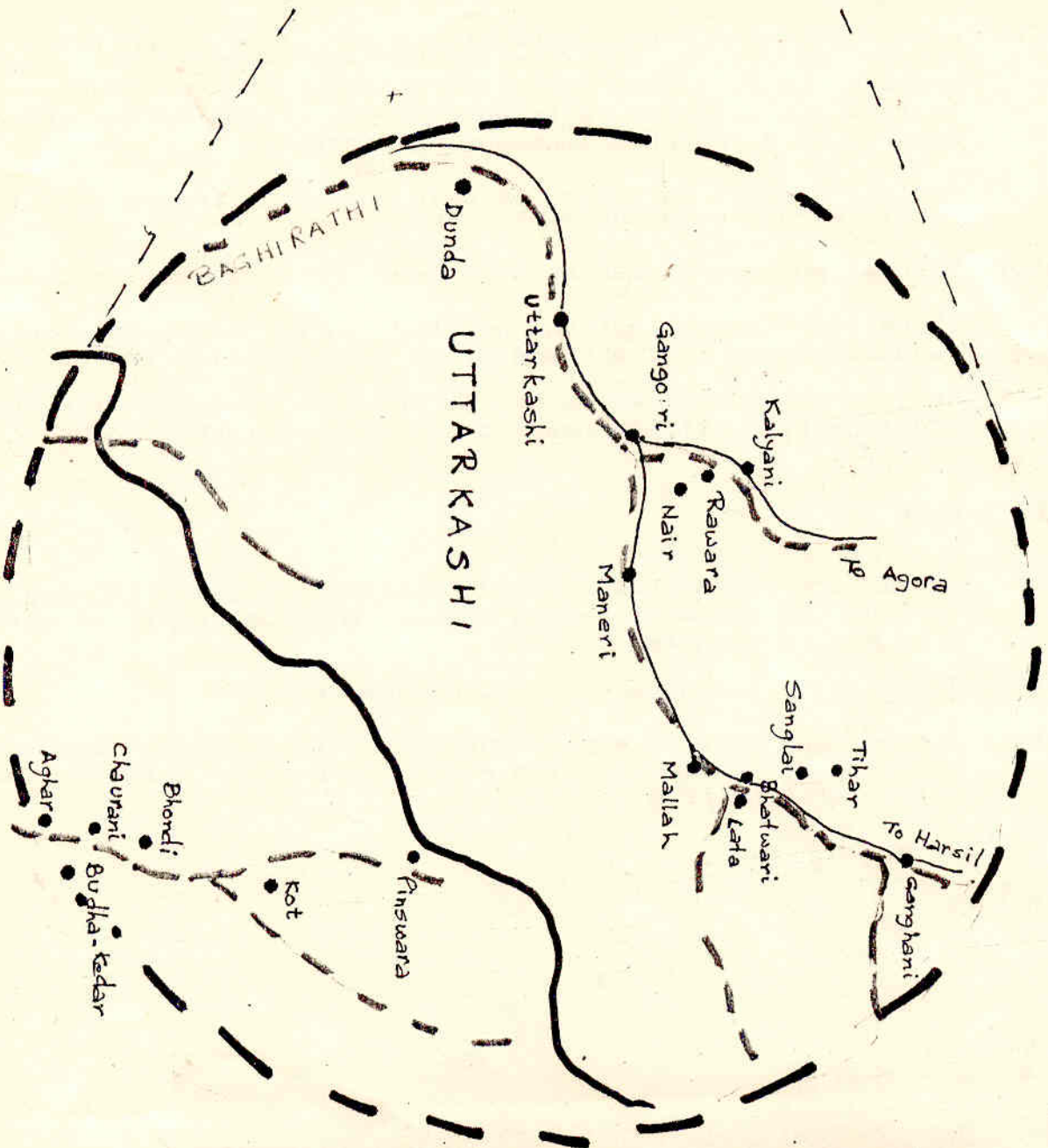
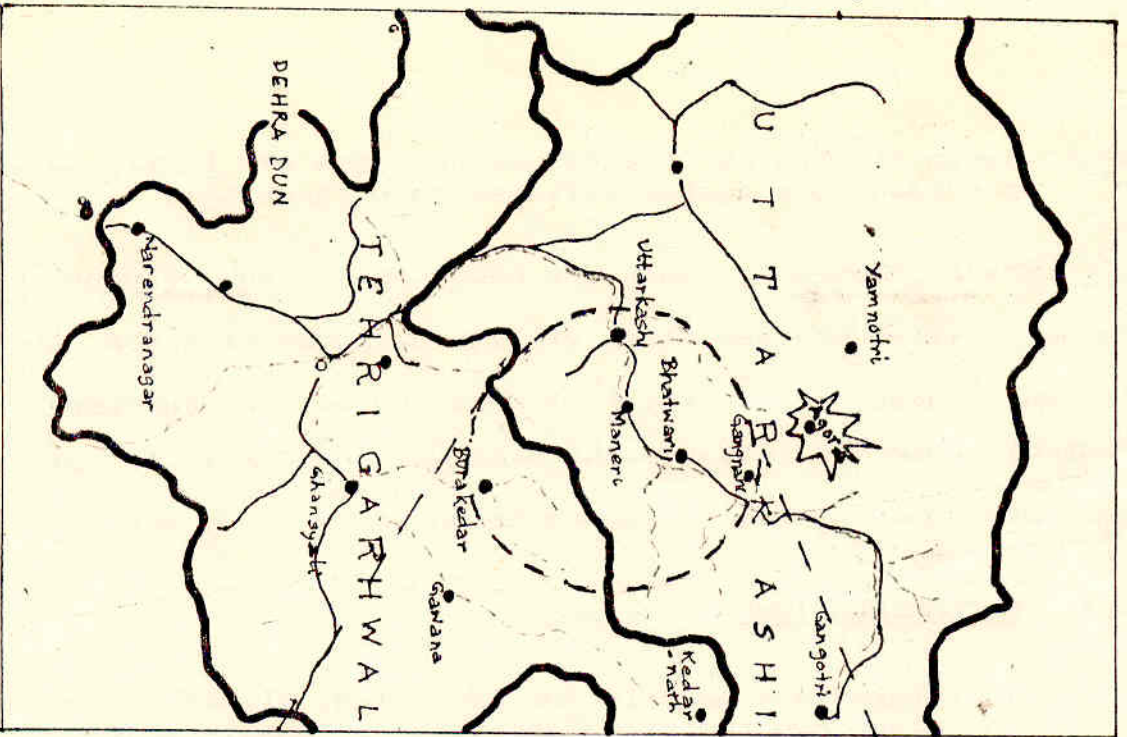
Roads clearance work has been undertaken. Jawans of the Garhwal Rifles are assisting villagers in removing the debris of fallen houses and removal of dead bodies or carcasses. The Control Room in Uttarakashi district, however, is still not equipped to guide relief donors to the more needy areas.

### III. RECOMMENDATIONS

- (i) The immediate need is for tarpaulin, blankets and quilts; and other construction materials for shelters (pictutre 3b)
- (ii) Government support, particularly for food supplies, is needed at least till the end of the snowfalls. There appears to be little scope for Food For Work programme at this stage, with snowfalls approaching. Long-term rations need to be given at a time during winter.
- (iii) Medical support is needed to help cope with trauma and the likely exposure to the winter cold.
- (iv) Special surveys focussing on women's problems are needed.
- (v) Scientific investigation of the threat of continuing landslides due to crack and other instabilities are needed.
- (vi) Long-term rehabilitation has to focus on evolving low-cost and locally available quake-proof housing technologies.

### PSI's Role

- (i) Channelize immediately needed supplies already organized by friends to the most needed areas. A second visit in mid-November is planned.
- (ii) Investigate the hazards posed by the cracks.
- (iii) Survey and develop employment generation schemes based on soil and water conservation works, as part of a longer-term rehabilitation programme.



Map showing villages visited.



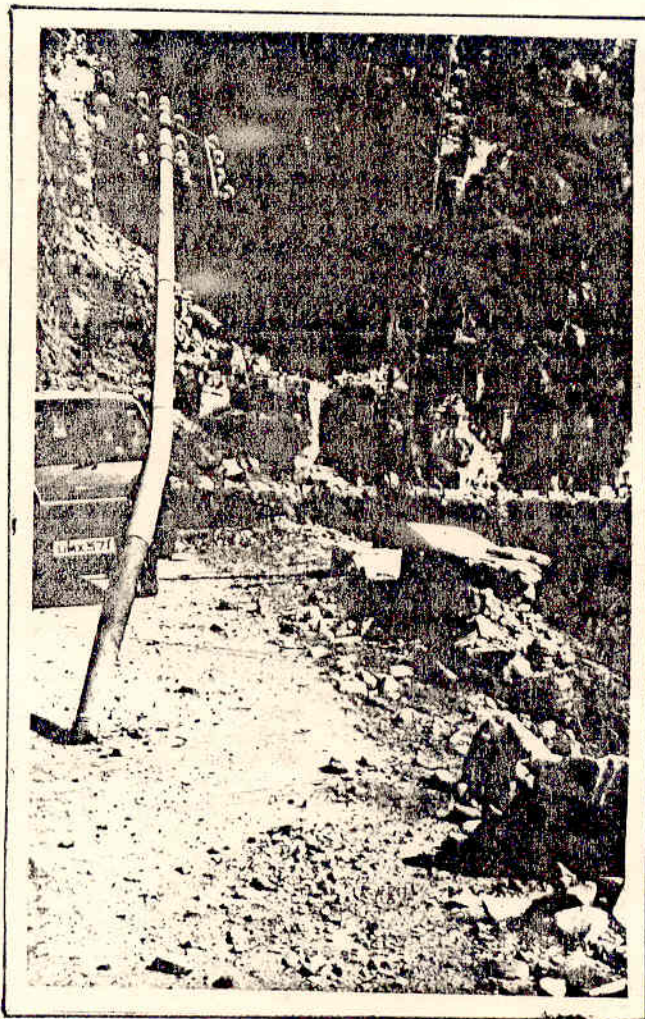
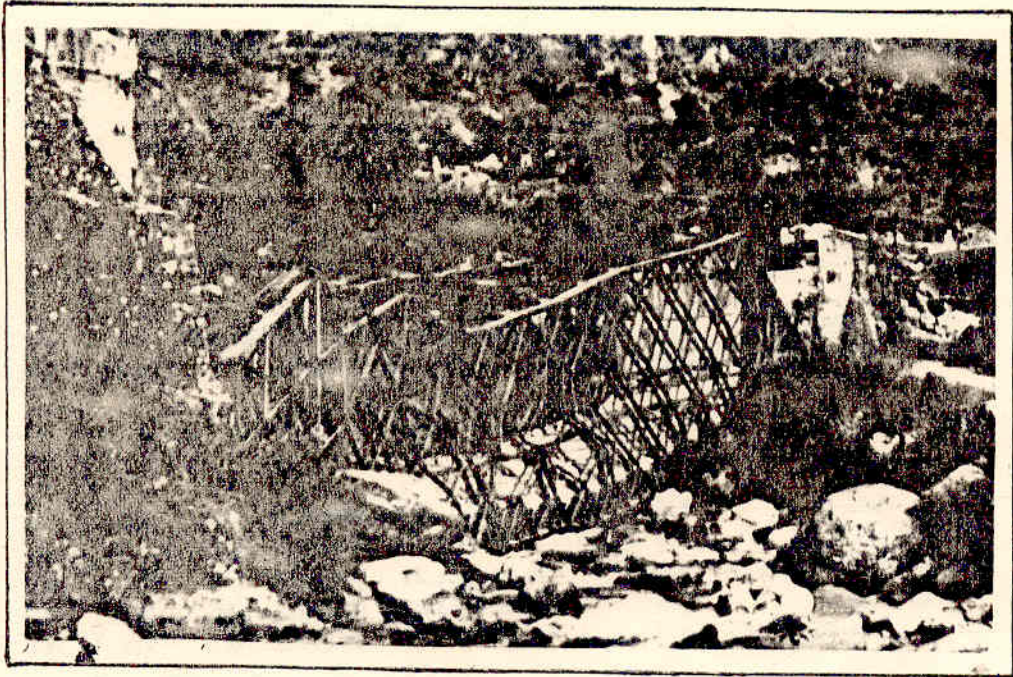
Table 1 : Damage and relief assessment in the surveyed villages

VILLAGE	DEATHS	HOUSE COLLAPSES	FIELD DAMAGE	CROP DAMAGE	LIVESTOCK	LANDSLIDES/ ROAD DAMAGE	SHELTER	RELIEF.....			
								Blanket	Ration	Compensatn (Rs.)	Exgratia Others
Tehri District											
Thati/Budha-kedar	-	Most Ck	N.S	-	NA	None/N.A	LH	Yes	Yes	10000	nil
Kot	5	All Cp	N.S	-	Majority Safe	None/N.S	LFO	Yes	Yes	10000	nil
Bhondi	-	25 Cp & Most Ck	F.D	-	Majority safe	None/N.S	LFS	Yes	Yes	10000	nil
Aghar	NA	Most Ck	N.S	-	Majority safe	None/N.S	LFS	Yes	Yes	10000	nil
Chaurani	2	Most Ck	N.S	-	Majority safe	None/N.S	LFS	Yes	Yes	10000	nil
Uttarkashi District											
Gangori	NA	N.A	F.D	-	NA	Few/Few	NA	NA	NA	nil	500
Rawar	NA	N.A	F.D	-	NA	Ext/Ext	LFS	NA	NA	nil	500
Kalyani	1	All CP/DM	F.D	-	NA	Ext/Ext	AR	NA	NA	nil	500
Sanglahi	14	All CP/DM	F.D	C.D	Most killed	Ext/N.A	LFS	Yes	Yes	nil	500
Maneri	NA	Most CP/DM	F.D	NA	NA	Ext/Ext	LFS	NA	NA	NA	NA
Rhatwari	NA	Most CP/DM	F.D	NA	NA	Ext/Ext	LFS	NA	NA	NA	NA

NOTES :

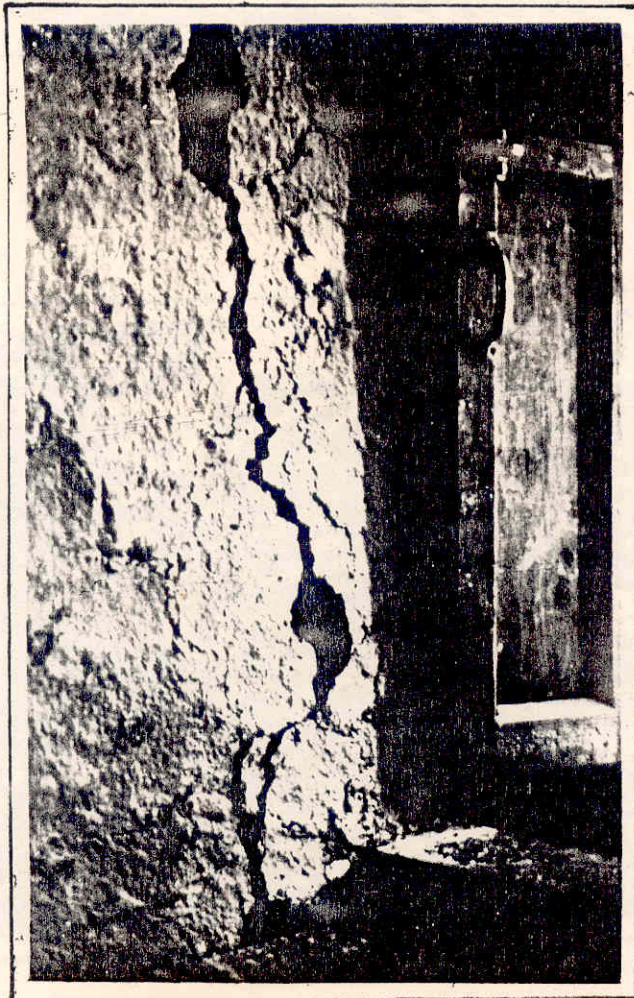
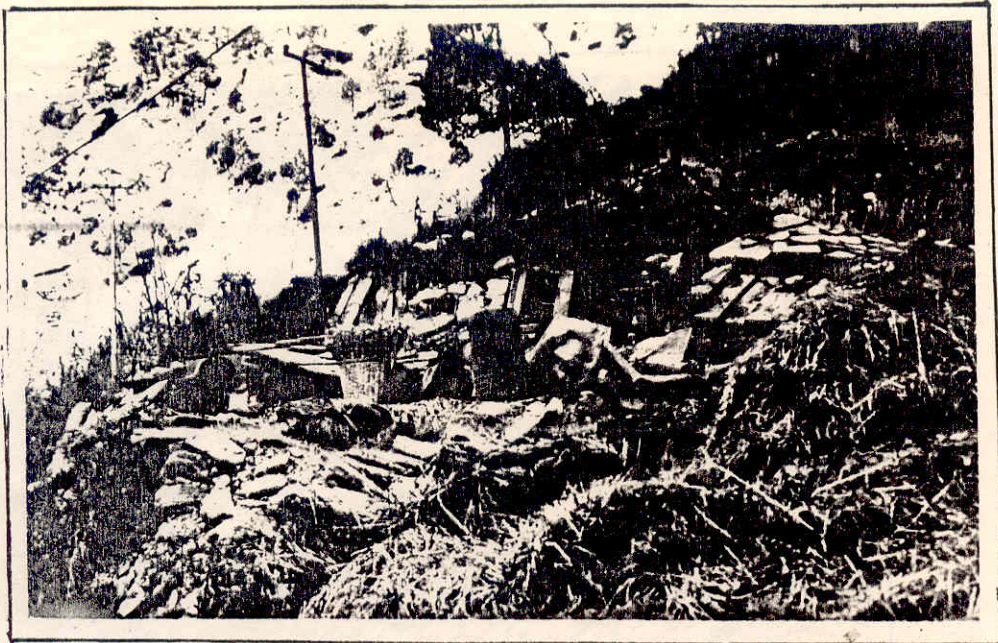
NA : Not available	N.S : Not Substantial
CP : Collapsed	EXT : Extensive
Ck : Cracked	LFO : Living in fields (open)
DM : Damaged	LFS : Living in fields (shelters)
	LH : Living in houses





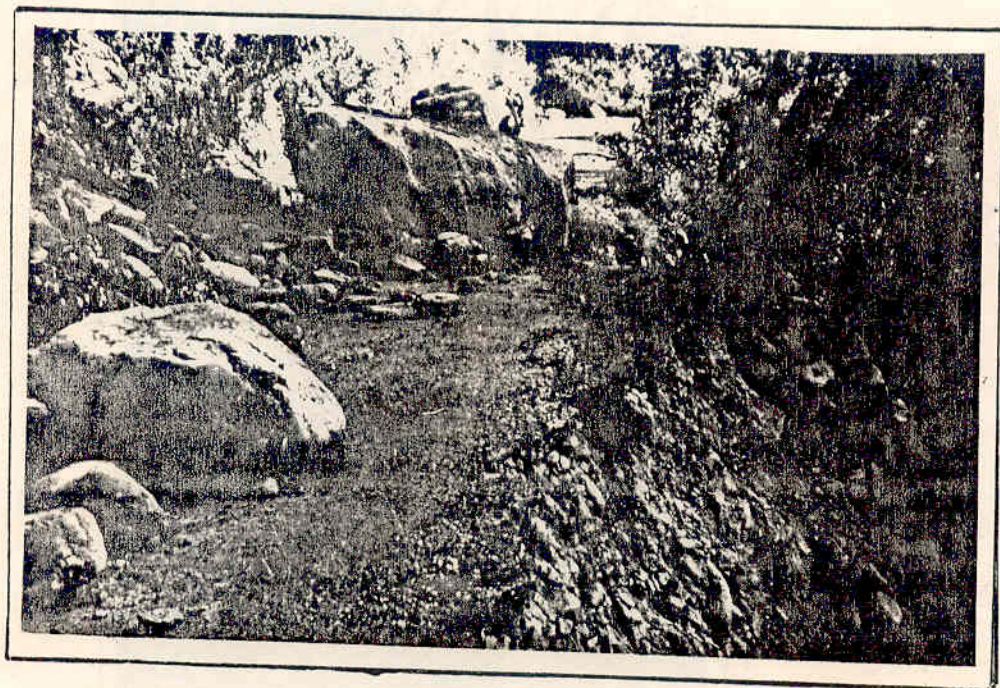
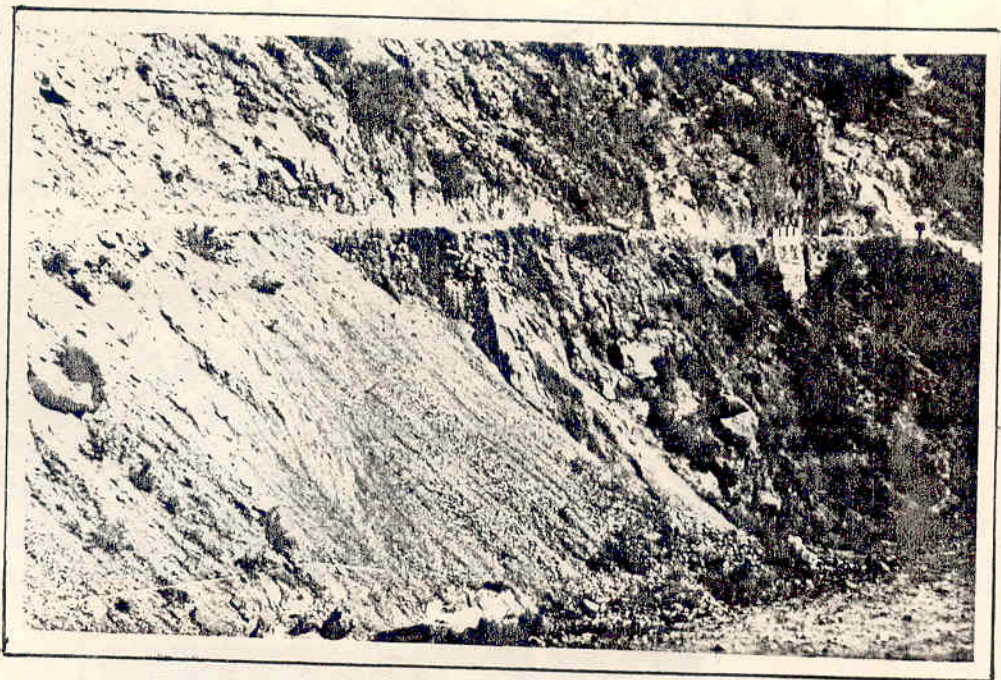
Infrastructural Damage : (1a) Collapse of the Maneri - Bhatwari bridge on the main road to Gangotri. (1b) Power lines and tele-  
phone poles uprooted in Maneri village.





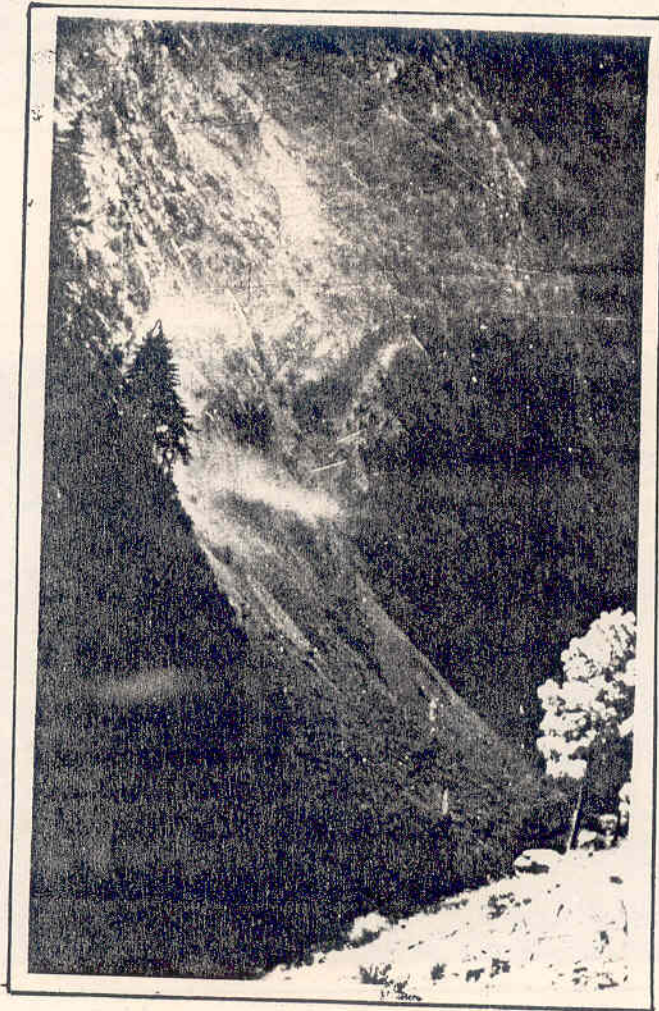
Housing Damage : (2a) In Sanglai village, the destruction was total. (2b) In Tehri-Garhwal, though most of the structures were standing, the damage was serious.





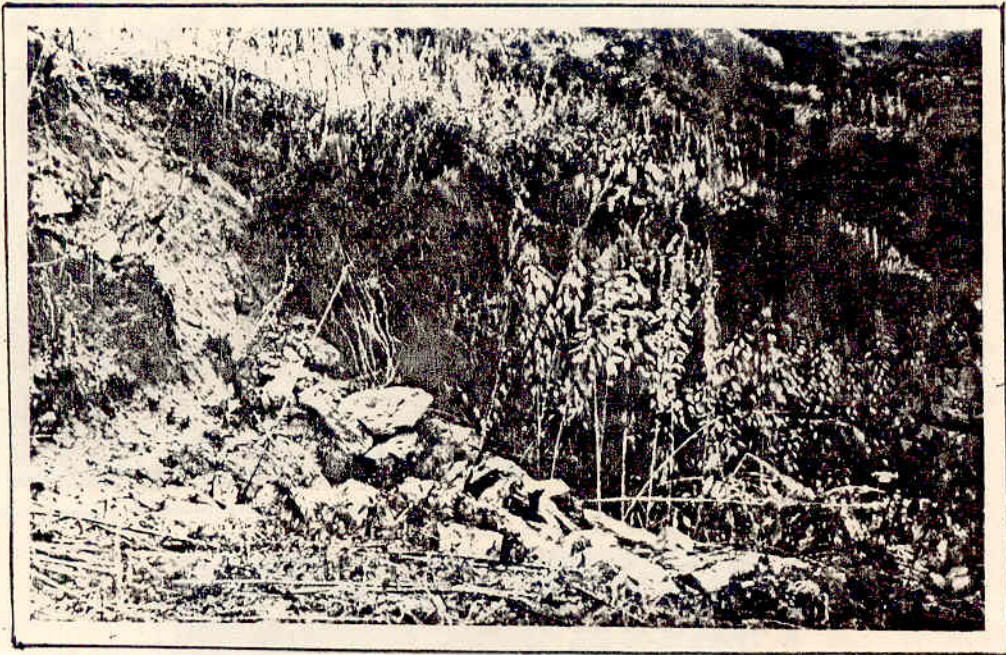
Landslides : (3a) In Uttarkashi, hill slopes where roads had been constructed suffered extensive damage. (3b) Massive boulders had blocked the road to Agora, the quake's epicentre.





Landslides: (4a) Despite the massive erosion, trees were still standing on the road to Kalyani. (4b) A massive landslide in progress on the Uttarkashi-Maneri road on 29.10.91. The debris were falling into the Bhagirathi river.





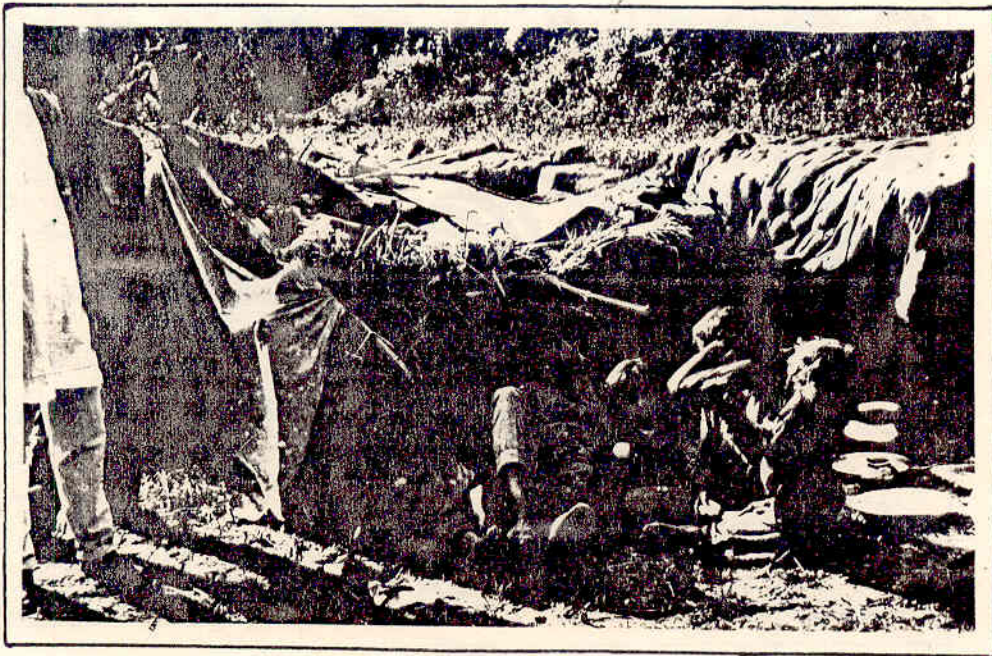
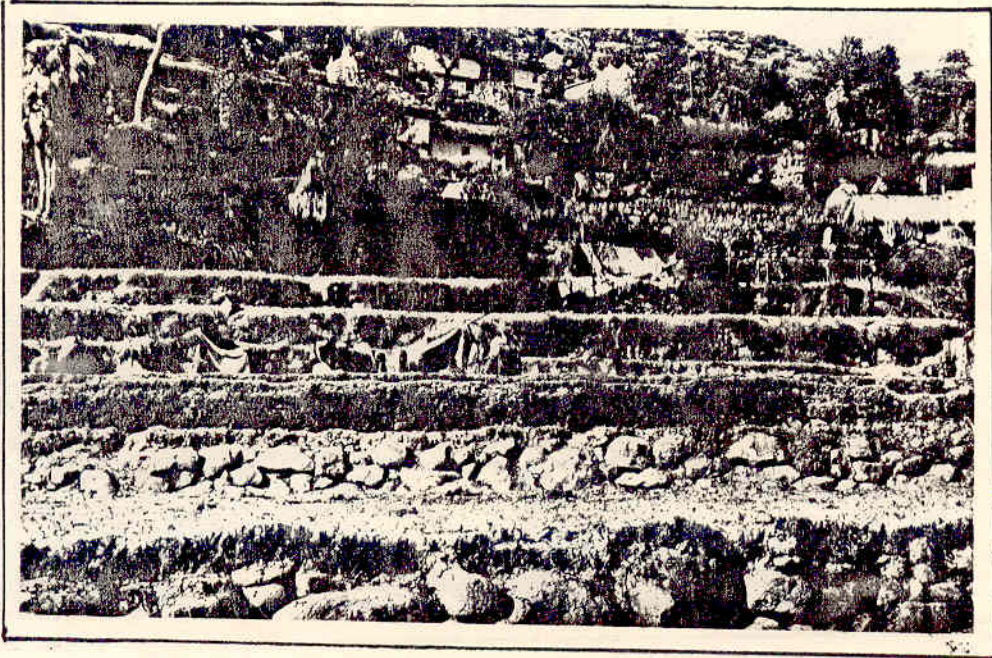
Agricultural Damage : (5a) Terrace wall destroyed by fallen rocks.  
(5b) Destruction of standing crops in Sanglai.





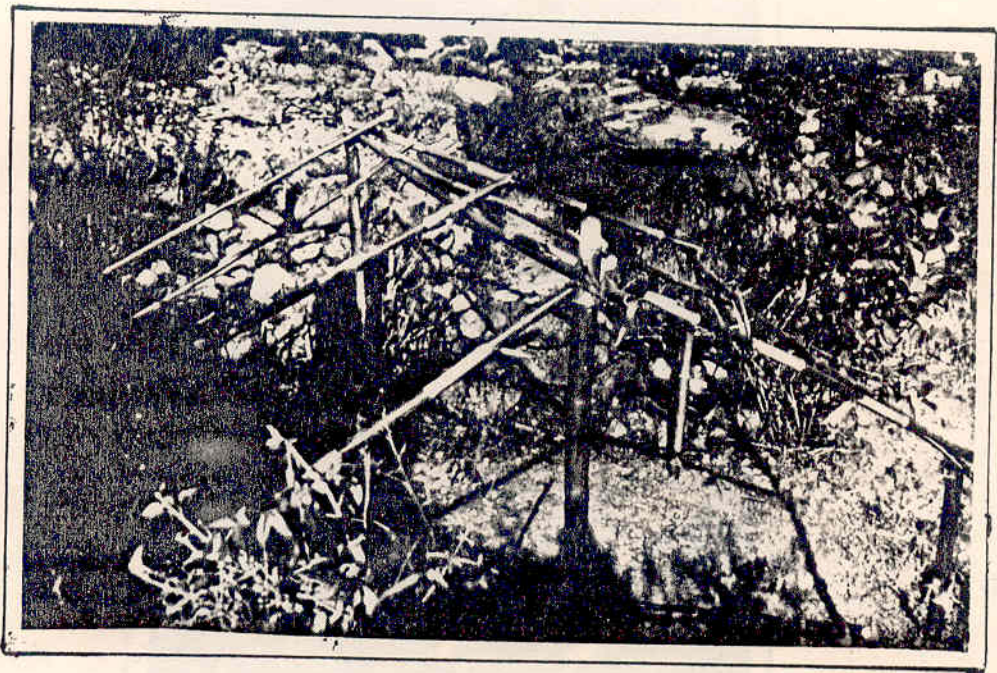
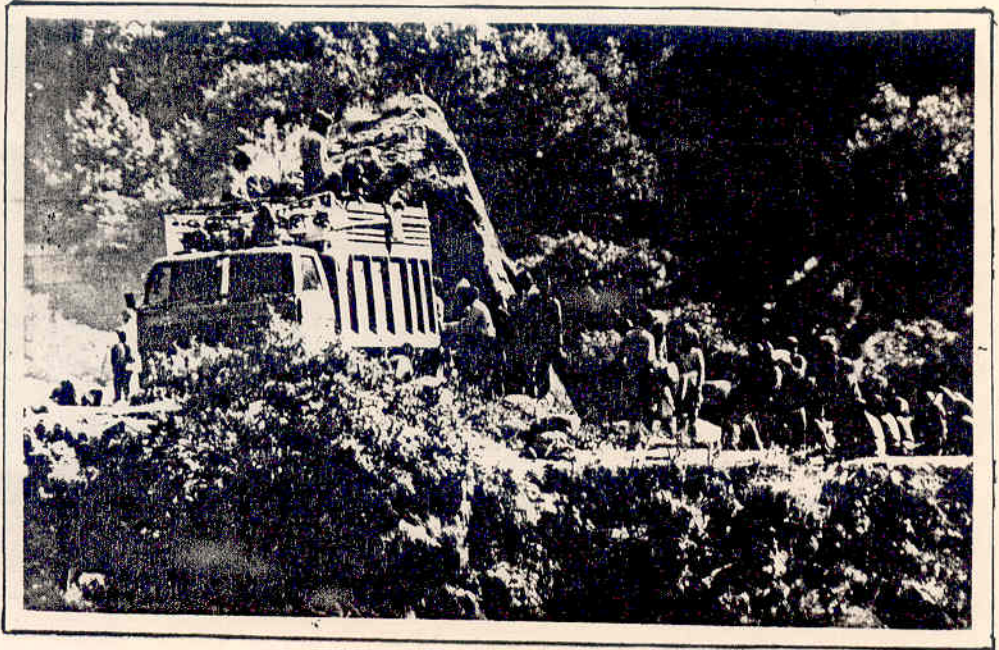
Livestock Loss : (6a) Buffalo trapped and killed under a shelter in Sanglai village. (6b) Remains of a cow's carcass near Kalyani village.





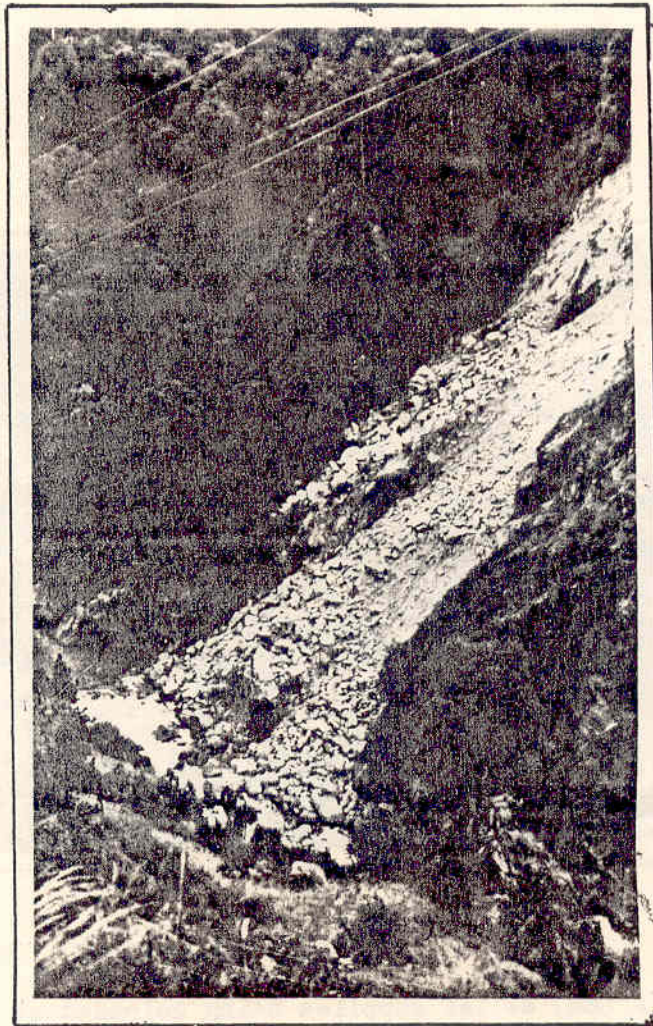
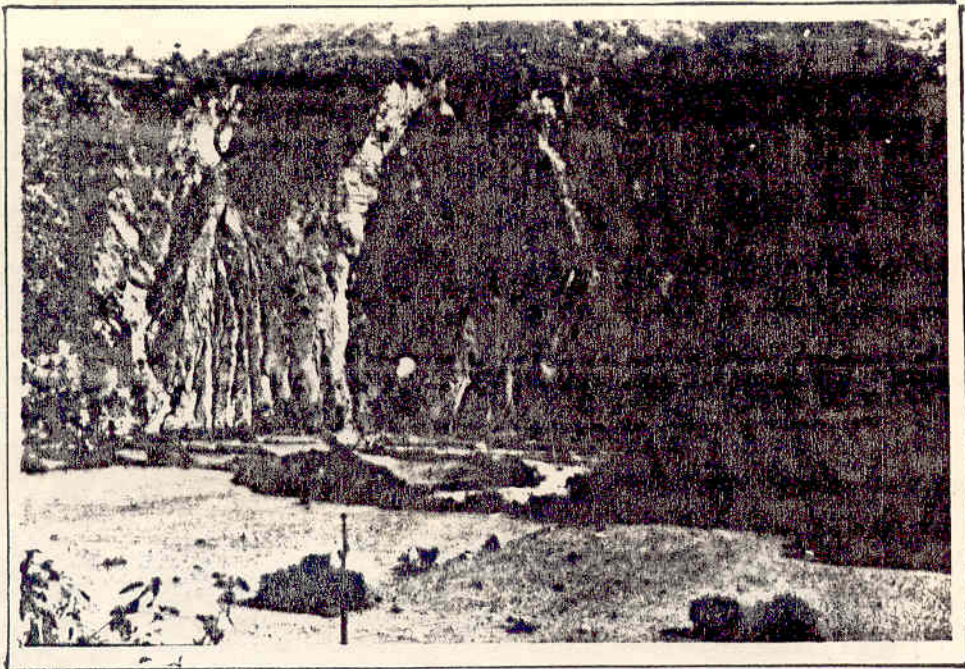
Temporary Shelters : (7a) People camping in open fields in a road-side village in Uttarkashi. (7b) Temporary shelter for a family in Tehri-Garhwal. The man's leg is injured. He and his wife lost two daughters.





Relief : (8a) Relief supplies being unloaded at a roadside village. (8b) Basic frame for a temporary shelter.





Fragile Slopes : (9a) The fragile slopes along the Bhagirathi valley near Tehri. (9b) Debris almost blocks the Bhagirathi below Sanglai village.







