

## Landslide Dam and Flooding

The Gona slide of Birehi Valley in the Garhwal Himalayas is a historically famous case. According to R.R. Pulford (Narrative Report on the Gona Lake and Flood Lucknow November 14, 1894), rockfall occurred in September 1893, damming the Birehi Ganges stream in Birehi Valley. However, the catastrophe came to pass only a year later, on August 26, 1895, when the water broke through the dam and damaged the valley, causing heavy destruction downstream in the Alaknanda Valley. Later, in their Survey of the Central Himalayas, Heim and Gansser (1939) reported scree material of limestone and limestone covering about 1.5sq.km with a maximum thickness of 300m. They estimated the volume at about 150 million cubic metres. The lake was four kilometres long and had a maximum width of 0.7km. In their estimate, the height of the rockfall was about 1,000 to 1,200m, and limestone had broken off from a dry rock wall due to stratification. It can be concluded that the rockfall occurred as a result of cloudburst.

A flood of very high intensity occurred in the Alaknanda River and its eastern tributaries in Garhwal on 20th July 1970, causing heavy loss of life and property. Belakuchi village was washed away and communications were disrupted due to the landslides that occurred on the bank of the river and its tributaries. The floods were caused by a cloudburst in the Kuanrikhal area at an altitude of 3,700m, which formed a lake at Birehi, a tributary of the Alaknanda. Later, this lake burst caused devastating floods (Kumar and Shome 1970). Similarly, the 1978 Bhagirathi floods were the result of the breaking of Lake Kandoligad, a tributary of the Bhagirathi.

It has now been established that the flash floods were caused by cloudbursts; they are common occurrences in the Himalayas. In August 1994, three cloudbursts in Kulu Valley, Himachal, swept away three villages causing great loss of life and property. In August 1993, a landslide occurred upstream of Jeori in the Sutlej Valley. A lake was formed, threatening the ongoing construction of the Nathpa-Jhakri power project. Timely action, which involved blowing out a part of the slide-created dam, saved the situation and averted the catastrophe.

Landslide control in the catchment area is an important aspect. It has a direct bearing on floods and the silt load accumulation downstream in the reservoirs of the engineering projects. Investigation of the catchment area is not only important for landslide control but also has great relevance for the siltation rates of reservoirs. A detailed study of the catchment area should include analyses of slope conditions, drainage, structural features, such as faults and joints, predominantly operating subarial processes, density of forest/vegetation cover, and land-use patterns.

Based on their study of slope failure in the catchment area of the Alaknanda and the Bhagirathi, Prasad and Verma (1980) suggest the following landslide control measures.

- a. Large-scale afforestation along the valley side: active slide faces must be protected from grazing and excessive felling of trees
- b. Protection of the toes of repose slopes by erecting stout embankments and diversion of stream flow from the toe by constructing gabion structures
- c. Headward extension of the gullies should be checked by making small dams
- d. If a lake is formed at high altitude, the water should be drained out slowly