

Debris Flow Preventive Measures

Mt. Unzen, Japan



Measure:	Rationale:
<i>Passive measures</i>	
Restrict use of hazard area	Define hazard zones, Restrict use of endangered areas
Warning systems	Provide warning to the public, before, during and after event
<i>Active measures, source area</i>	
Reforestation	Re-plant eroding and unstable slopes
Watershed management	Control harvesting and road building, clean out debris
Stabilization of debris sources	Slide stabilization, check dams, erosion sills
<i>Active measures, transportation zone*</i>	
Channel improvements, diversion	Clean out, straighten, enlarge and reinforce channels to avoid overflow, control direction of movement and reduce channel erosion
Bridges or viaducts designed for passage	Provide bridges with adequate openings to prevent blockage of debris flow channel
“Sacrificial” bridges, fords	Design bridges not to block the flow or be severely damaged in the event of burial
Bypass tunnels beneath stream bed	Divert road into a tunnel beneath the stream bed or deposition area

After Hungr et al., 1987

<i>Active measures, Deposition zone*</i>	
Channels (“shooting channels”)	Construct a smooth, confined channel to encourage debris flow travel to the distal reaches of a fan
Deflecting dykes/walls	Place oblique or curving dykes or walls, to force depositing debris flow surges into a pre-determined area.
Open debris basins	Use dykes or walls as before, to encourage deposition in a given area, Excess material is allowed to continue downstream
Closed debris basins (barriers)	Stop debris flow surges, strain and retain coarse debris, allow only water and fine-grained sediment to continue downstream.
Debris sheds	Protect highway with a shed structure, debris flow to deposit on the roof or overflow further downstream.

*The limits of transportation and deposition zones are understood as those applicable after the defensive measures are in place. Channels and chutes will move the point of deposition downstream, barriers and basins upstream.



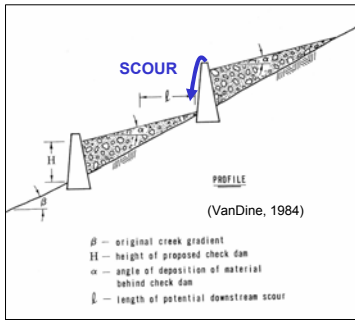
Check dams and erosion sills stabilizing a slope on Mt. Nantai-san, near Nikko, Japan.



Check dams stabilizing the headwall of a watershed near Toblach, South Tirol, Italy.



Check dams stabilizing a channel near Toblach, South Tirol, Italy.



Check dams stabilizing a channel at Mt. Nantai-san, Honshu, Japan



A "shooting channel" conducting a debris flow channel through the village of Matrei, Austria. The bridges can be lifted at the time of danger

A lined channel designed for passage of debris flows on Alberta Creek, Lions' Bay, British Columbia

**Landslide Induced Debris
Flows of August 2005
(Brienz)
(Prof. S.Loew, ETH
Zurich)**



A channel conducting mud flows through the village of Lamosano, below the Tessina landslide, Northern Italy. The channel can be flushed by diverting water into it. (Photo by E. Bromhead, University of Kingston, UK.)



A segment of debris flow fan constrained by deflecting dykes, Arlberg, Austria.



A debris flow deflecting dyke at the head of a debris flow fan near Hiroshima, Japan.



Deflecting dykes constructed around the community of Port Alice, Vancouver Island, B.C. in 1978 (Photo H.Nasmith).



Following a debris flow in the spring, 2003 (Photo BC Forest Service)



An open debris basin at Cheam View near Chilliwack, B.C. The brown material is the deposit of a debris flow retained by the basin. A low trash rack protects the outlet.



An open debris basin protecting the native village of Oweekeno, B.C. coast. Note figure near centre of photo for scale.



A large check dam just above the apex of a debris flow fan, near Hiroshima, Japan.



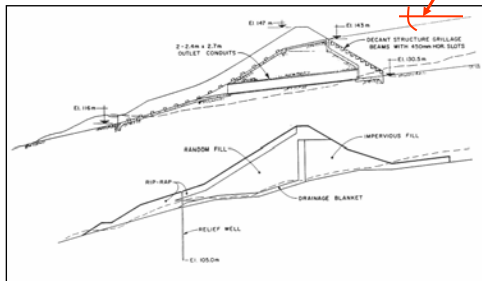
Two debris barriers near Lienz, Austria.



A debris flow barrier in Western Taiwan.



An engineered earthfill barrier on Charles Creek, Lions' Bay, B.C., designed to retain 30000 m³ of debris



"Debris storage angle"



An engineered earthfill barrier on Charles Creek, Lions' Bay, B.C., designed to retain 30000 m³ of debris (John Price, KPA, Vancouver)



November 16, 2007
Charles Creek



A debris barrier on Whistler Creek, Whistler, B.C., designed to retain 30000 m³ of debris.



Three debris flow bridges in eastern Turkey, allowing debris flows from steep tributary valleys to cross a national road.



A debris flow bridge in the Savoy Alps, France



A long avalanche shed providing protection from rock fall and small debris flows on a talus slope, Switzerland.



Mt. Stephen debris flow deposition area on the CP Rail main line, Kicking Horse Pass before and after the construction of a debris shed.



Mt. Stephen snow/debris shed,
aerial view