U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 01-443
Plate 1

Map of Landslides Triggered by Hurricane Mitch, Cobán Quadrangle (2162-III), Guatemala

This map is 1 of 20 that shows areas impacted by landslides adjacent to the Motagua and Polochic river valleys of Guatemala in response to the torrential rainfall that accompanied Hurricane Mitch in October and November of 1998. The maps provide a comprehensive record of landslides over a large geographic area (~10,000 km2) of diverse geology, geomorphology, microclimates, and vegetation. If combined with data on the physical properties of hillslope-mantling materials, hillslope form, and rainfall characteristics, the maps provide a foundation for evaluating the susceptibility of other similar areas to landsliding.

We use the term "landslide" to describe all types of slope failures, rotational and translational slides, slow-moving earth flows, (Varnes, 1978; Cruden and Varnes, 1996), and fast-moving debris flows composed of mud, gravel (up to boulder-sized material) and organic debris that often mobilize from landslides (see Pierson and Costa, 1987, for classification of fast-moving flows). Most of the landslides that we mapped were debris flows. Debris flows typically occur in response to periods of intense rainfall. They initiate as rotational or translational slides that mobilize into muddy slurries, or from significant concentrated erosion of surface material by runoff. As they travel across hillslopes and down channels, the slurries can substantially increase in volume by incorporating additional colluvium, channel-fill material, and water. Addition of sufficient volumes of water relative to sediment content can also result in dilution of the debris flow to streamflow consistency. Debris flows can occur with little warning and are capable of transporting coarse debris (containing fragments as large as 5 m in longest dimension) long distances over relatively gentle slopes. Debris flows can develop momentum as well as impact forces that can cause considerable destruction. As a result of these characteristics, mitigation of debris-flow hazards can be more difficult than mitigation of flood hazards. Most of the landslide-related damage and deaths that occurred during Hurricane Mitch were a result of debris flows.

Aerial photographs taken between January and March 2000 were used to map the landslides. The 1:40,000-scale aerial photographs were taken as part of a map revision project of Instituto Geografico Nacional (IGN) and the National Imaging and Mapping Agency (NIMA). Copies of the photographs are available through the EROS Data Center. Digital Raster Graphics (DRG) scanned images of 1:50,000-scale quadrangles were used as base maps for mapping the landslides. For some quadrangles, landslides were mapped on 1:25,000-scale enlargements of the base maps. Landslides and related effects in and adjacent to downstream drainages were mapped by first identifying them on the aerial photographs using a Kern PG-2 photogrammetric plotter at 4X and 8X magnifications.

The plotter is traditionally used to create topographic maps, but also has many geologic applications (Pillmore, 1989). The photographs were scaled and oriented to the topographic base map using prominent topographic landmarks and plotted on a transparent polyester overlay registered to the topographic base. The mapped landslides were digitized manually or by an optical scanner, and the data were then digitally registered to the DRG base map in ArcInfo. The maps accurately portray the shape, size, and relative location of landslides and related downslope channel deposits. However, in some locations mapped channel deposits are not well aligned with the drainages as shown on the base maps. This may be due to 1) differences between generalized mapping of drainages on the base maps and detailed mapping of landslide channel deposits, 2) changes in the courses of streams since the time the base maps were made, and 3) locally insufficient topographic control to accurately register the aerial photographs to the base maps. Considering all mapping errors, we estimate that landslide locations mapped using the plotter are typically accurate to within 50-100 m. In areas where landslides were very sparse, the aerial photographs were scanned with a mirror stereoscope at 4X magnification, and landslide locations were transferred to base maps by inspection. Locations of landslides mapped in this manner are estimated to be accurate to within approximately 200 m. Final maps are presented at 1:50,000 scale.

This work was done in collaboration with Instituto Nacional de Sismologia, Vulcanologia, Meteorologia e Hidrologia (INSIVUMEH) with funding from U.S. Agency for International Development (USAID).

References Cited

Cruden, D.M. and Varnes, D.J., 1996, Landslide types and processes, in Turner, A.K. and Schuster, R.L., eds., Landslides—investigation and mitigation: Washington, D.C., National Academy Press, Transportation Research Board Special Report 247, p. 36-75.

Pierson, T.C. and Costa, J.E., 1987, A rheologic classification of subaerial sediment-water flows, in Costa, J.E. and Wieczorek, G.F., eds., Debris flows/avalanches–process, recognition, and mitigation: Geological Society of America, Reviews in Engineering Geology, v. 7, p. 1-12.

Pillmore, C.L., 1989, Geologic photogrammetry in the U.S. Geological Survey: Photogrammetric Engineering and Remote Sensing, v. 55, p. 1185-1189.

Varnes, D.J. 1978, Slope movement types and processes, in Schuster, R.L., and Krizek, R.J., eds., Landslides: analysis and control: Washington, D.C., National Academy of Sciences, Transportation Research Board Special Report 176, p. 12-33.

A PDF file for this map is available at
http://geology.cr.usgs.gov/greenwood-pubs.html