



Extreme rainfall and debris flows from an orographic thunderstorm in the Eastern Italian Alps

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The upper Adige river basin, in Northern Italy, occupy a distinctive hydrometeorological niche, characterised by high frequency of orographic thunderstorms. Relatively small-extent flash floods and debris flows are triggered by these storm events. The hydrometeorological and hydrological controls of these events are examined through analyses of a storm system occurred on August 1, 2005 on the Rio Gola river basin (6.59 km², Eastern Italian Alps, Adige river basin). The intense orographic convective system produced locally extreme rainfall peaks in 1.5 hours. The storm concentrated on small, rocky and steeply sloping basin where concentrated overland flow feeds ephemeral channels incised in slope deposits. Despite the short duration of the event the storm triggered an unusually large debris flow, with a volume of about 100,000 m³, producing significant geomorphological impacts and abrupt changes in the extent of incision and channel widening. Hydrometeorological analyses of the storm are based on radar reflectivity observations, raingauge and streamgauge data. The orographic organization of the precipitation system is examined by means of the hypsometric rainfall moments. Detailed geomorphological field surveys, rainfall estimates from radar observations, and the application of a distributed hydrological model in comparison with observed discharge, served as the basis to evaluate erosion processes and quantify the water runoff production at the initiation debris flow area. The hydrological analysis is used to evaluate the consistency among the different observations and to identify the critical factors controlling the debris flow triggering. The hydrological analysis shows that the critical factor is storm concentration on rocky and steeply surfaces and formation of concentrated surface flow at the bottom of channels filled by coarse loose debris.