Cloud-to-ground lightning characteristics of storms that trigger debris-flows in complex terrain in the Mediterranean region

Jeffrey Underwood

University of Nevada, Reno Nevada, USA (jeffu@unr.edu / +01.775.784.6999)

It is very common for summer season convective storms in the Mediterranean region to produce copious rainfall totals. A small population of these storms produce short lived, but very intense rainfall in the region. These intense rainfall episodes can produce devastating hydrological responses in complex terrain where vegetation cover has been disturbed or where slope material is unconsolidated. Debris flows and flash floods are among the hydrological hazards associated with these types of storms (Tecca et al. 2003; Cannon and Reneau 2000). This study investigates the morphology of convective storms that produce short, but intense periods of rainfall over complex terrain in northeastern Italy. One objective of this research is to develop cloud-to-ground (CG) lightning flash parameters that when combined with measures of convective instability and storm motion can be used to identify storms with potential to produce short bursts of intense rainfall in regions of complex terrain in the Mediterranean area.

For the study two dates were identified where convective rainfall produced debris flows in the study region. The storm date 12 June 1997 corresponds to debris flow observations near Cortina d'Ampezzo (Berti et al. 1999). The storm date of 7 August 1996 corresponds to debris flow observations at Cancia and reported by Bacchini and Zannoni (2003). Both of the debris flows were triggered by intense convective rainfall in the region. Data collected at both sites provides the rainfall chronology and the time of debris flow initiation. Upper-air data and thermodynamic parameters from Udine (LIPD) and Milano (LIML) were obtained from the NOAA Integrated Global Radiosonde Archive (NOAA 2007). CG flash data for the storm events were purchased from CESI-SIRF.

A number of CG lightning flash parameters were calculated for a period beginning 90-minutes prior to the intense rainfall episodes. These parameters included: flash location and spatial patterns, time of flashes relative to rainfall initiation, polarity of flash population, spatial and temporal sequence of polarity shifts, peak current of flash population, 1-minute, 5-minute, and 10-minute flash rates. Multiple spatial and temporal scales of analysis were employed in the analysis.

Convective storms produced peak rainfall rates as great as 1.0mm/min at both debris flow sites. The 12 June 1997 storm dumped more than 22mm of rainfall in 35 minutes in the late afternoon. A smaller convective rainfall episode in the early afternoon on that date may have played a role in intensifying the later storm by entraining moisture in a layer from 750hPa to 550hPa. Preliminary results suggest that peak CG flash rate (5-min) and time of CG flash peak are the best of the prognostic parameters tested to this point.

References:

Berti, M., R. Genevois, A. Simoni, and P.R. Tecca (1999). Field observations of a debris flow event in the Dolomites. *Geomorphology*, 29, 265-274.

Bracchini M. and A. Zonnoni (2003). Relations between rainfall and triggering of debris flows: case study of Cancia (Dolomites, Northeastern Italy). *Natural Hazards and Earth Systems Sciences*, 3, 71-79.

Cannon , S.H, and S.L.Reneau (2000). Conditions for generation of fire-related debris flows, Capulin Canyon, New Mexico. E*arth Surface Processes Landforms*, 25, 1103-1121.

NOAA Satellite and Information Service and the National Climatic Data Center, US Dept of Commerce

(website accessed: May 2007) http://lwf.ncdc.noaa.gov/oa/climate/igra/index.ph

Tecca, R.R., A. Galgaro, R. Genevois, adn A.M. Deganutti (2003). Development of a remotely controlled debris flow monitoring system in the Dolomites. *Hydrological Processes*, 17, 1771-1784.