The Utility of Cloud-to-Ground Lightning for Debris Flow Warning in the Dolomites of NE Italy

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Study Area: Figures 1 and 2 locate the study area in NE Italy. The instrumented study area is in the Acquabona watershed near the village of Cortina d'Ampezzo. This region of the Dolomite experiences one of the highest return intervals for debris flow in all of Europe. Figure 1 also illustrates the superimposed LTG observation boundaries for the study (r = 100km, r = 50km, r = 25km)

Figure 1.

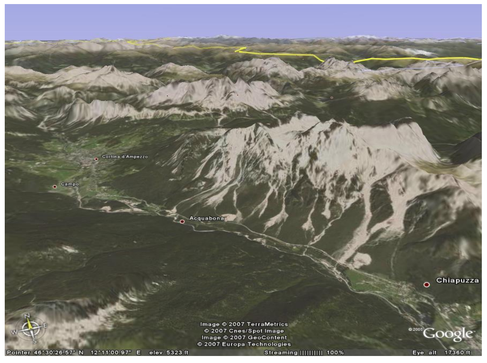

Figure 2

Figures 3 and 4 show some of the instrumentation Installed in active debris channels and at debris sources areas of the study site. Research has been conducted continuously at the site since the 1990's.

Figure 3.

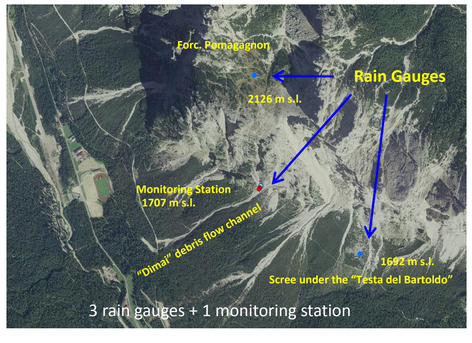

Figure 4.

For the first time the project will include atmospheric electricity parameters to further the study of preconditions for localized intense convective rainfall (LICR) that in turn generate runoff and initiate debris flows. This study of archive events uses data sets including: on-site observed rainfall intensity, on site (witnessed) debris flow initiation; cloud-to-ground lightning flashes (CESI-SIRF Italian Lightning Detection Network)

To ensure that CGF and rainfall are co-located in space in time a ratio analysis was performed and the results presented in Table 1 was performed. These results provide guidance and empirical evidence for co-location and suggests that there is utility in using CGF data for debris flow analysis and the development of debris flow warnings.

Table 1.

Indicator/Spatial Scale	100km	50/100km	25/50km
Mean Total CGF (ratio)	100%	14%	19%
Mean Total CGF (#)	1249	174	30
Mean % Positive CGF (ratio)	100%	18%	25%
Mean % Positive CGF (#)	67	12	3

The pilot analysis shows the outcomes of six events from 1996-2006. Shown in the 60 minute time series is the five minute rainfall totals (mm) the five-minute CGF totals, and the five-minute calculation of percent positive flashes. Figures 5 through 10 are event examples Figure 11 is a composite graphic.

Figure 5

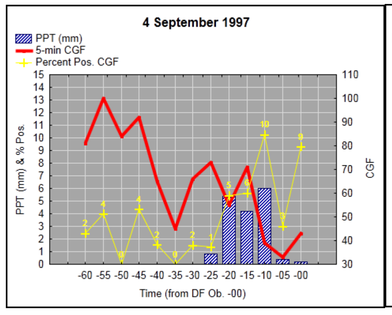

Figure 6.

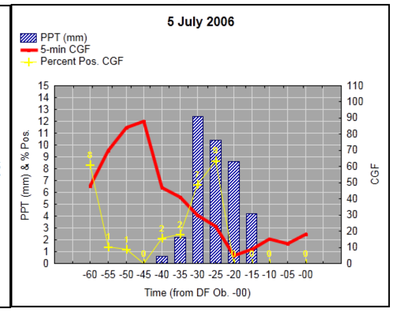

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Figure 7

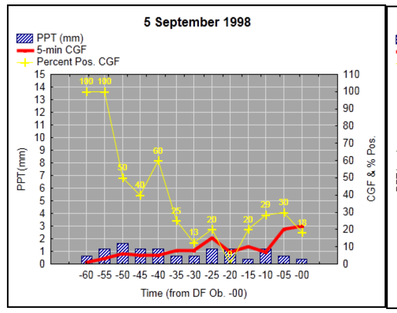


Figure 8.

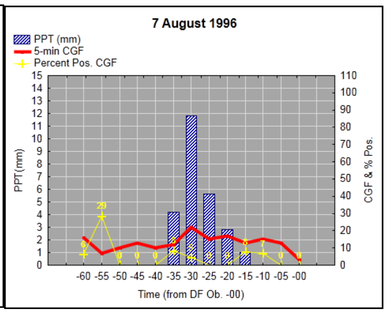


Figure 9

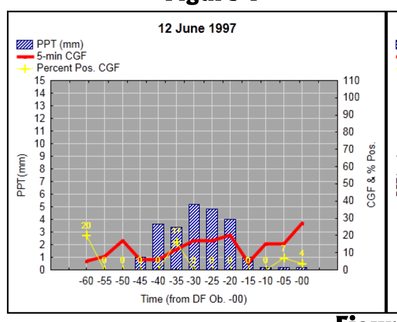


Figure10.

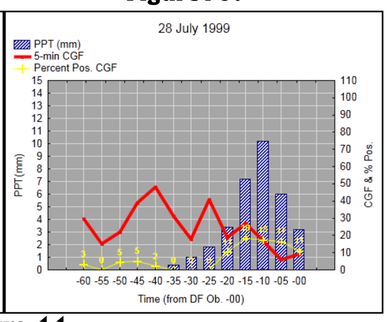
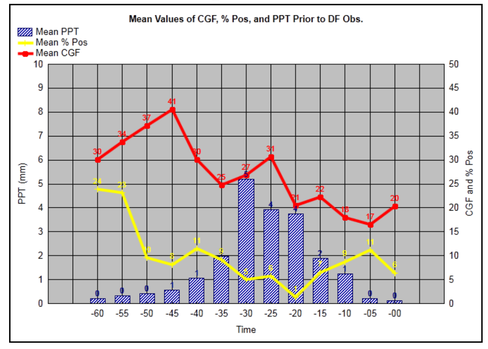


Figure 11 .



Summary: CGF in this region of the Dolomite Alps do provide utility for the analysis of hydro-meteorological outcomes such as intense rainfall and debris flows. In the six pilot events the mean time from peak CGF to DF observation was ~35minutes and time from peak %pos was ~10minutes prior to DF observation. CGF peak coincided with intense rainfall (with a lag of less than 20 minutes.

Future Directions: With funding from the Ministero Dell'instruzione, dell'universita e dell ricerca the research Team will install an Electric Field Meter (EFM) this summer To allow further investigation of the linkages between Atmospheric electricity and extreme hydrological outcomes.