SPATIAL INTERPOLATION OF HOURLY GAUGE AND RADAR PRECIPITATION DURING MAP SOP

Jože Rakovec[1], Mojca Dolinar[2], Miha Demšar[1], Stefano Micheletti[3]

[1] Chair of Meteorology, FMF, University of Ljubljana, Jadranska 19, SI-1000 Ljubljana, Slovenia
[2] Environmental Agency of the Republic of Slovenia, Vojkova 1b, SI-1000 Ljubljana, Slovenia
[3] ARPA-OSMER of Friuli Venezia Giulia, Via Oberdan, 18/a I-33040 Visco (UD), Italy
E-mail: *joze.rakovec@fmf.uni-lj.si*

Abstract: During MAP SOP (fall 1999) a network of additional automatic rain gauges was installed in the mountains of western Slovenia. The meteorological radar in Fossalon (OSMER, FVG) was operational as well. Raingauges are considered to provide measurements with good point accuracy, but offer little information on the spatial variability of precipitation. On the other hand the radar measurements give very good image of spatial distribution of precipitation, but the absolute quantity of precipitation is unreliable due to several systematic errors, especially occultation in mountainous areas. Different geostatistical aproaches are tested to improve spatial distribution of precipitation, using raingauge and radar measurements. The spatial distribution of precipitation shows that the location of precipitation maxima is well correlated to the topographic features of the area and that the operational automatic gauge network is not dense enough to detect the spatial variability of precipitation in a scale of individual watersheds. The use of additional MAP data proved to be of great use, for example for such event as the one of heavy rainfall and debris flow in Loška Koritnica Valley in 2000.

Keywords *– radar precipitation measurements, raingauge precipitation mesaurements, spatial interpolation, MAP data, heavy rainfall event*

1. INTRODUCTION

Climatologically there are two precipitation maxima at the southern side of the Alps in Ticino and in Julian and Karnic Alps (Frei and Schär, 1998). Very heavy rainfall events may occur such as the one triggering a massive landslide during the night of November 16–17, 2000. The village of Log pod Mangartom, Slovenia, located in the Julian Alps, was hit by a debris flow of about one million cubic meters of morainic material and slope gravel resulting in seven casualties (i.e. Brilly et al., 2001, 2002). The landslide seems to have been caused by accumulation of precipitation in slope material during the wet summer and autumn 2000 and finally triggered by an intense rainfall on 15th of November. For such extreme events it is rather essential to know the exact position of the strongesr precipitation. As normally the ground measuremens with rain gauges are not dense enough for what we attempt here – to obtain the fine scale regionalization of the accumulated precipitation by combining the radar data on precipitation event with the ground measured data, and using additional relief- relevant information

2. METHODS

Considering the references (Todini, 2001; Velasco-Forero et al., 2003) we decided to test the kriging spatialization methods. Radar output was available in the form of 30-minutes rainfall intensity in 500 m grid. Exploratory data analysis was preformed to find relations between rain gauge accumulations and radar accumulations. Spatial distribution of precipitation was calculated in the same grid as radar precipitation to compare spatial distribution obtained from different measurement resources. According to the fact that we focused on the small mountainous area, with small number of observation (not regarding the density of observation), three different spatialization models were tested:

- Ordinary kriging on rain gauge measurements (OK)
- Ordinary kriging on rain gauge measurements using radar variogram (OK – RV)
- Residual kriging with deterministic part describing rain gauge – radar relation (RK – R)

The complete description of geostatistical methods can be found in Isacs and Srivastava (1989) in Cresie (1993) or in other geostatistical literature. Cross-validation technique was used to help select direct and cross-variogram models for all the methods and finally to validate the spatialization results.

3. DATA

Precipitation from classical rain-gauge stations - at this stage only 11 stations on Slovenian side of the area of our study (Figure 1), were used for spatialization procedure. Table 1 provides a list of different types of ground meteorological stations with their specification. The spatial density of stations depends on the time resolution of measurements and also on the collection time lag. The densiest is the rain gauge station network with daily precipitation sum. The data from automatic weather stations and pluviograph network have much better time resolution (5 min). For the study area radar measurements from Fossalon (OSMER, FVG) were available at 500-m spatial and 30-minutes time resolution.

Table 1: Specifications of ground meteorological stations:

station	height	time resolution
Log pod Mangrtom	648	5 minutes and day
Kneške Ravne	752	5 minutes and day
Rateče-Planica	864	5 minutes and day
Bovec	441	5 minutes
Breginj	550	5 minutes
Žaga	353	day
Soča	487	day
Trenta	622	day
Kobarid	230	day
Livek	695	day
Kranjska Gora	804	day

3. CASE STUDY

The analysis was performed for the time period from the beginning of October 2000 till the end of November 2000 in upper Soča valley, when 2-month precipitation amount exceeded 100-year return period. The amount of precipitation was extremely high in November, when in Koritnica watershed the monthly sum 4-times exceeded long term monthly mean (Figure 1). One of the consequences of two-month heavy rainfall, was a catastrophic debris flow on the 18th November 2000, which took 7 lives. The daily precipitation amount for station Log pod Mangartom is shown in Figure 2.

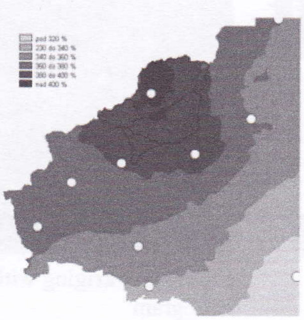


Figure 1. Precipitation in November 2000 in upper Soča valley compared to 1961-1990 averages with Koritnica watershade and locations of precipitation stations indicated on the map.

The analysis was preformed on hourly and daily basis. For hourly analysis we had chosen events with strong precipitation (14th November at 18 UTC, 20 UTC and 21 UTC). Additionally we tested methods for accumulated precipitation in the period with strong precipitation, just before the landslide event (from the 13th November 2:00 UTC to 15th November 6:00 UTC).

4. RESULTS

The results of spatialization using different kriging methods are presented in Figures 3 to 5. The radar information is used for determining the variogram (Figures c); this information improves the spatial distribution; still the results are not yet satisfactory on hourly basis. (Maybe the inclusion of the rain gauge data also from Italian side of the mountain ridge might improve the overall performance of the method - not tested at the time of writing this extended abstract).

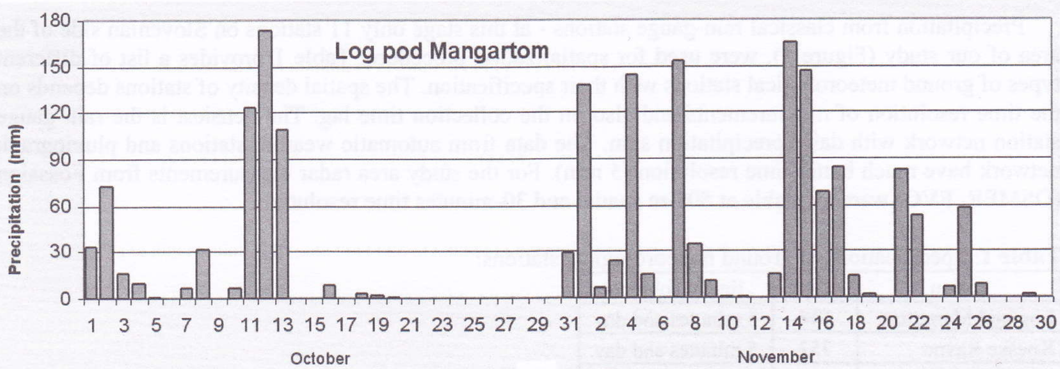
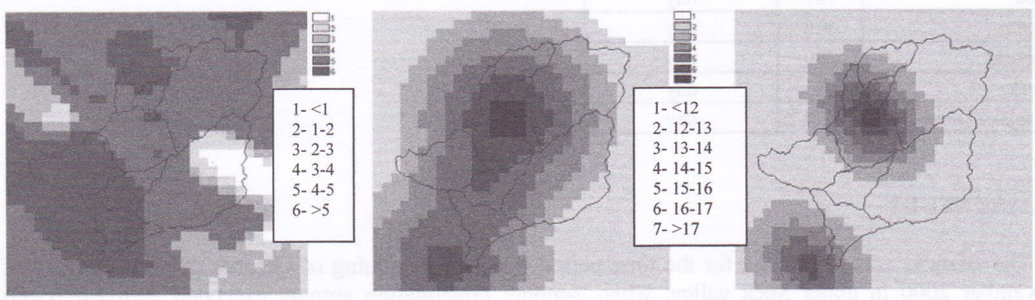
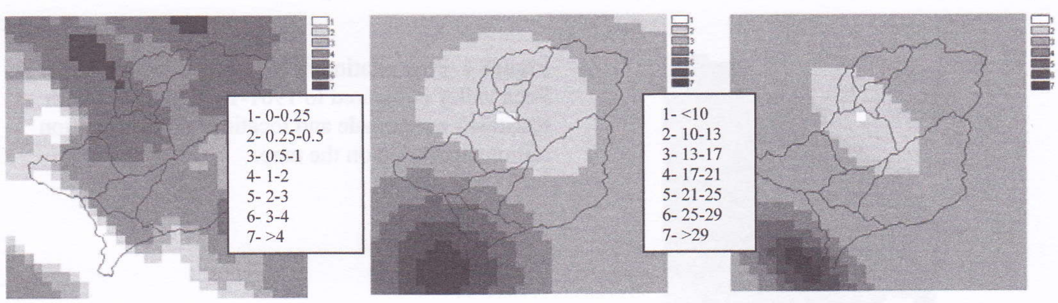


Figure 2. Daily precipitation amount for October and November 2000 in Log pod Mangartom (Upper Soča/Isonzo valley)



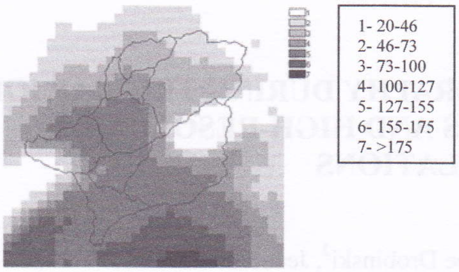
a. Radar measurements b. Ordinary kriging c. Ordinary kriging with radar variogram

Figure 3. Hourly accumulated precipitation on 14th November 2000 from 17:00 - 18:00 UTC

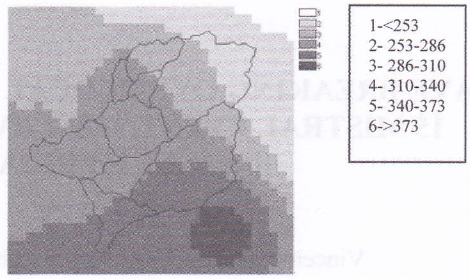


a. Radar measurements b. Ordinary kriging c. Ordinary kriging with radar variogram

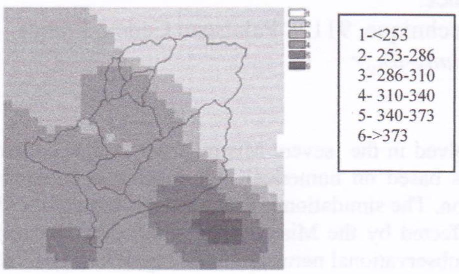
Figure 4. As Figure 3, but from 20:00 - 21:00 UTC



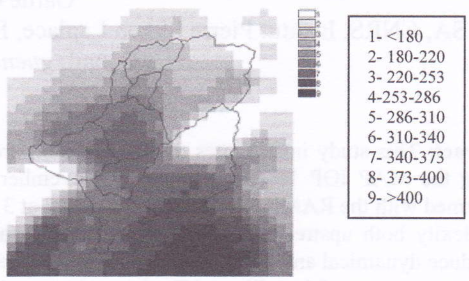
a. Radar measurements



b. Ordinary kriging



c. Ordinary kriging with radar variogram



d. Residual kriging with radar measurements

Figure 5. The 28-hours accumulated precipitation - from the 13th November 2:00 UTC to 15th November 6:00 UTC

5. CONCLUSIONS

The radar data for the considered case considerably underestimates the precipitation amount on hourly basis. For longer time-periods the radar coverage enables the spatialization to the very fine scale – while for the quantitative values the method relies mostly upon the ground based rain gauge measurements. The combination of the two data sources proves to be useful in the very rough mountainous terrain.

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