"REVIEWED"

SEASONAL PRECIPITATION EFFECTS OF HAIL SUPPRESSION IN SERBIA

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ABSTRACT

Reanalysis of previously treated precipitation data (Aleksic, 1989) shows that nearly all of the precipitation changes which could be attributed to hail suppression are occurring in May and June.

1. INTRODUCTION

One of the questions associated with hail suppression activities is whether they inadvertently influence rainfall amounts. In a recent paper, Aleksic (1988) addressed this matter by statistical analysis of precipitation data from several stations in Serbia.

In this study, daily precipitation amounts for convective days, for some 20 May-September seasons (covering periods both before and after introduction of hail suppression) were analyzed for three stations in the protected and four in the unprotected area. A convective day was defined as a day with observed precipitating Cb.

A tentative conclusion derived on the basis of parametric tests is that precipitation at the protected stations in the period of suppression changed from the preceding period in a way which cannot be explained by similar changes at the unprotected stations. This change is attributed to the inadvertent hail suppression effect. The point estimate of the change (based on double ratio statistic) is a net 23% increase of rainfall on convective days. At the 95% confidence level the estimate shows an increase in the interval (9%, 40%).

These values represent gross changes for the whole of the May-September hail suppression season. In a private communication, E.K. Bigg (1990) suggested reexamination of results from the point of view of these changes having possibly not been evenly distributed throughout the season. Follow-up of his suggestion produced some interesting results which are presented in this note.

2. REANALYSIS

The primary data base used by Aleksic (1989) consisted of the hourly observations from the seven available main meteorological stations, with positions shown in Fig. 1. Analysis has covered the period approximately from 1960 to 1979. These observations served to make convective day calendars with corresponding daily amounts of precipitation for the May-September (e.g., hail suppression) season. For each station, two samples of daily precipitation were taken from the calendar, one for the historic (before suppression) period and the other for the hail suppression period. For unprotected stations, 1969 was arbitrarily defined as the beginning year of the protection period.

Subsequent inquiry of homogeneity has shown that it is possible to pool the samples into four groups (as in Table 1). These four pooled samples then formed a base for further analysis. Statistic of interest was a double ratio,

$$r = \frac{p_2/p_1}{u_2/u_1}$$

Where p_2 and p_1 are means for protected stations in historic and protection periods; u_1 and u_2 have the same meaning for unprotected stations. Details on the statistical procedures used can be found in the original paper.

We stress that the aim of this reanalysis is not to repeat all the significance tests applied in the previous study. It is beyond dispute (Tukey et al., 1978) that reanalysis is usually exploration and not confirmation. Bearing in mind that even the original study was only an exploratory analysis of the historic data, we feel that any such testing would only be an academic exercise. Instead, we are looking for an after-the-fact insight which might serve as useful information in future quests.

Thus, we have only rearranged the original data base to obtain mean rainfall amounts for convective days separately for each month, instead of for the season May-September as before. The results are shown in the Table 1.

3. DISCUSSION

A fresh look at the old data produced a somewhat surprising result. May and June show apparent increases of daily precipitation amounts in convective days of about 50% while July and August exhibit even small (though probably not significant) decreases.

The month of September also shows an apparent increase in precipitation. However, we should be very cautious in trying to assign any particular importance to this apparent change, because one record storm (84.8 mm) influenced the mean in the protected stations/historic period sample by more than 10%.

Thus, we end by noting that most of the changes in precipitation tend to be concentrated in the spring part of the hail suppression season. We are still unable to point with reasonable certainty at any physical mechanism responsible for this phenomenon.

One thing that should be checked, however, is whether the dominant air masses in the area differ in these two periods. It just might be that spring clouds have more pronounced maritime characteristics and so be more susceptible to stimulation.

REFERENCES

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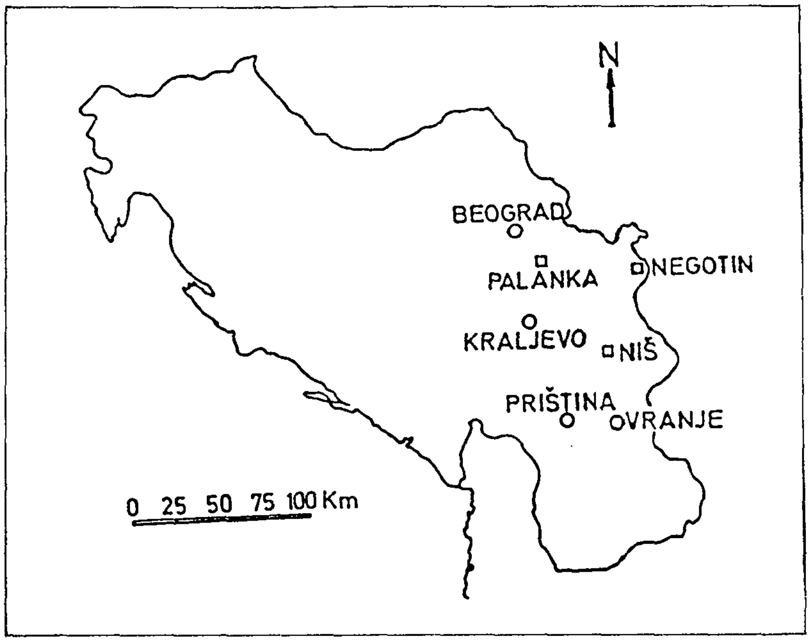

Fig. 1: **Geographical positions of the chosen stations. Protected stations are marked by square, unprotected ones by circles.**

Table 1: **Mean daily precipitation amounts (mm) in convective days.**

Stations	Period	Seasonal	Maj	June	July	August	September
Protected	Historic	5.90	3.80	5.80	7.00	6.10	7.10
Protected	Protection	8.20	7.10	9.30	7.80	7.20	11.20
Unprotected	Historic	7.60	6.70	7.30	8.20	6.60	10.10
Unprotected	Protection	8.60	7.50	8.10	9.60	8.60	9.50
Double ratio r		1.23	1.67	1.44	0.95	0.92	1.68