

A SPECIFIC EVIDENCE OF HAIL SUPPRESSION EFFECTIVENESS IN SERBIA

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Abstract. In 40 years period (1967-2006) of continuous hail suppression operations in Serbia only in 1999 it was interrupted due to NATO bombing. In that year the hail-swept agricultural area was 3.5 times larger then in other ten years in the period 1992-2002 when the hail suppression system was operating under similar conditions.

1. INTRODUCTION

Hail suppression operations in Serbia started 1967 and it has been conducting by the Republic Hydrometeorological Service of Serbia. The methodology is described in the Operative and Scientific Research Project »Hail Control« (Radinović, 1972). The evaluation of the effectiveness of hail suppression has been based on the size of the hail-swept agricultural area in hectares (Radinović, 1989), or derived from radar measurements (Ćurić, 1990). The hail swept agricultural area has been taking place through qualified commissions, which have been set up by the local authorities (the municipalities).

In the period 1967-1991 the Hail suppression system in Serbia was in developing phase. Methodology and technique were improving and the system was spreading up covering by the end of this period over 90% of total agricultural area in Serbia. Evaluation for the period 1971-1987, when Hail suppression system has been operating without interruptions, shown the effectiveness to 74% (Radinović, 1989).

2. A PARTICULAR EVIDENCE OF HAIL SUPPRESSION EFFECTIVENESS IN SERBIA

In the period 1992-2002 Hail suppression system in Serbia (Fig. 1) has been operating in stable conditions, that is without significant changes. There were 13 radar centers, 1780 hail rocket launching stations, 5.100,000 hectares of total agricultural area and 4.500,000 hectares of agricultural area covered by the Hail suppression system.

The evaluation of the hail suppression effectiveness for the period 1992-2002 has been made by the Republic Hydrometeorological

Service of Serbia. The results obtained are shown in Fig. 2.

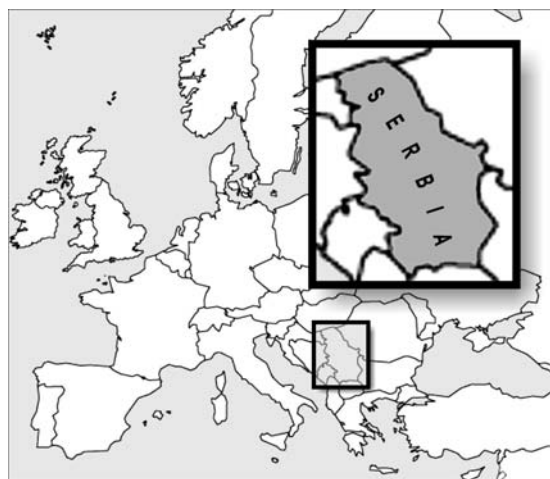


Fig. 1. Map of Serbia

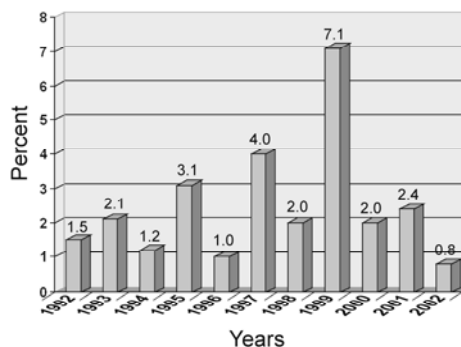


Fig. 2. The percent of hail-swept area in relation to the protected agricultural area (Republic Hydrometeorological Service of Serbia, 2002).

From Figure 2 it may be seen that in ten years (1992-2002, except 1999) the protected agricultural area has been hail-swept 0.8-4.0 % annual or 2 % in average for the whole period. In

1999 from 24 March until 12 June, when hail in Serbia most frequently occurs, Serbia was bombed by NATO. The Hail suppression system was interrupted because the radar observations could not be taking place until the end of July. In this year hail swept 7.1 % of protected agricultural area in Serbia. That is 3.5 times more than an average for the ten years of surrounding period. In another words, in years when Hail suppression system has been operating, the hail-swept agricultural area was reduced by about 72% in relation to 1999 when the system was out of operation. This is nearly the same effectiveness as is obtained for the period 1971-1987 (Radinović, 1989), shown in Table 1.

Table 1. Percentages of hail-swept areas of protected (R_p) and unprotected (R_u) territories as well as their ratio (Q) (modified, from Radinović, 1989)

Years	R_p	R_u	Q
1971	4.60	9.28	0.496
1972	4.35	6.87	0.633
1973	4.64	8.30	0.559
1974	3.45	8.20	0.420
1975	2.05	8.54	0.240
1976	1.37	5.52	0.249
1977	5.20	9.19	0.566
1978	2.73	8.03	0.340
1979	1.66	2.86	0.580
1980	2.08	6.90	0.301
1981	1.97	6.83	0.288
1982	1.95	11.06	0.176
1983	0.92	3.30	0.279
1984	1.05	1.17	0.892
1985	0.63	****	*****
1986	1.46	2.40	0.607
1987	0.90	0.06	14.152

If we split the hail suppression season in 1999 into an interrupted part (April-July) and the rest uninterrupted part (August-October), according to observations, in the first interrupted part 7% of agriculture area was hail-swept. In the second protected part of the season only 0.1% of agriculture area was hail swept. Usually, in second part of the season, as it is divided here, the hail-swept agriculture area is about one order less than in the first part of the season.

3. CONCLUSION

The NATO bombing to Serbia, from the meteorological point of view, was not expected nor predicted. Therefore, it may be considered as an incident by chance. From Table 1 it may be seen that the percentage of hail-swept area in the unprotected territory from 1971 to 1987 amounts to about 7 %. At the same time the percentage of hail-swept area in the protected territory amounts about 2.5%. It is in full accordance with the percentage of hail-swept area in Serbia in the period 1992-2002 when the Hail suppression system has been operating and when it was interrupted due to bombing.

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