Greek National Hail Suppression Program

The Hellenic Agricultural Insurance Organization (ELGA) is the main insurance carrier of plant production and livestock capital in Greece. It is a State Organization whose main income is the premiums paid by farmers. The Hail Suppression Program is applied by ELGA as an action in the framework of active protection to mitigate the damages caused by hail in cultivation.

The Greek National Hail Suppression Program is applied from March 20th up to September 30th in Central Makedonia and Thessaly in northern and central Greece respectively, covering a total of 5,200 square kilometers (Figure 1).

Figure 1: Project areas of Hellenic National Hail Suppression Program

The Meteorological Applications Centre is the Department of ELGA responsible for the implementation of the Program. It is based in Thessaloniki Makedonia Airport and consists mainly of scientific meteorological staff (12 meteorologists). It cooperates with the supply company "3D" in a contract from the year 2014 to 2019, which offers 3 Piper Cheyenne turboprop airplanes, 2 meteorological C-band Radar, 6 Pilots and 6 Co-pilots, and cloud seeding silver iodide flares of 20 and 75g.

The Program is based on the conceptual model of "Beneficial Competition", introducing artificial nuclei in the hailstorms that compete with the natural ones for the available supercooled water, forming smaller hailstones, thus increasing the possibility to melt during their fall, reaching the ground as rain.

The implementation is based on the specialized meteorological forecast for the occurrence of hail storms, the meteorological Radars that detect and record them and the specially equipped airplanes with launching or firing systems for silver iodide flares. The airplanes, under the guidance of the Radar meteorologist, perform seeding flights by releasing artificial nuclei of Silver Iodide in the storm clouds.

The seeding techniques include the primary top seeding technique at the -10^{0}C level and the less common (due to orographic terrain and poor visibility restrictions) base seeding technique. The criteria to perform seeding in a candidate storm include convective radar echo with reflectivities exceeding 35 dBz above the -5^{0}C level with an intensifying tension.

Figure 2 shows a thunderstorm and Figure 3 depicts the Radar echoes display with TITAN software system, respectively.

Figure 2: Thunderstorm

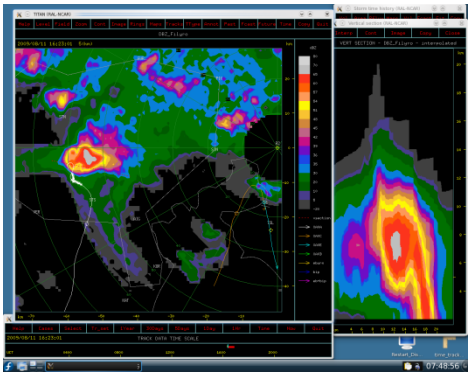

Figure 3: TITAN – Radar echoes display

Table 1 presents the values of operational parameters from the last two periods 2015 and 2016 and the average and maximum values of the decade 2004-2013. The presented parameters are the Number of operational days which is the sum of seeding and patrol days. A seeding day is characterized as a day when there is at least one seeding flight. A patrol day is when all flights of that day are patrol flights. The Number of operational flights is the sum of the number of seeding and patrol flights, and respectively the Flight hours are the sum of hours of the seeding and patrol flights. The seeding material consumption is expressed with the Number of 20g and 75g flares burned in the clouds. The Total number of storms are storms that are identified inside the protected areas and the Number of storms in Central Makedonia (North project area). Lastly, we have the Number of hail days defined as days with recorded hail on hailpads and the number of hailpads with hail.

Table 1: Values of operational parameters of periods 2015 and 2016 and the average and maximum values of the decade 2004-2013

	2015 period	**2016 period**	**Average**	**Max.**
Number of operational days (Seeding/Patrol)	62 (47 / 15)	63 (39 / 24)	52.4	71
Number of operational flights	150	136	115.5	163
Flight hours	514.3	436	349.9	477.8
Number of 20g flares burned	16,629	13,000	12,898	19,549
Number of 75g flares burned	97	207	237	537

	2015 period	2016 period	Average	Max.
Total number of storms	257	173	-	-
Number of storms in Central Makedonia (North project area)	141	134	-	-
Number of hail days	14	14	14.1	20
Number of hailpads with hail	87	70	75	124

The Hail Suppression Program has been evaluated by the Aristotle University of Thessaloniki according to a randomized design of target-control areas with the main contribution of a dense hailpad network. The statistical evaluation revealed success rates ranging from 35% to 72% in 21 parameters such as the average hail diameter, number of hailstones, kinetic energy etc. Consequently, the economic assessment showed that the compensation payments for hail damage to agricultural crops are limited by 58%, and the affected areas by 30% in the target areas sample compared with the control areas sample.

In addition, the study of the Aristotle University of Thessaloniki for the impact of the Program on terrestrial and aquatic ecosystems in the protected areas has shown that ecosystems are not burdened by confirming the results of similar surveys that were preceded by other countries.

Finally, as the contract with a private company ends in 2019, ELGA will proceed in the near future announcing for a new Declaration of International Competition.