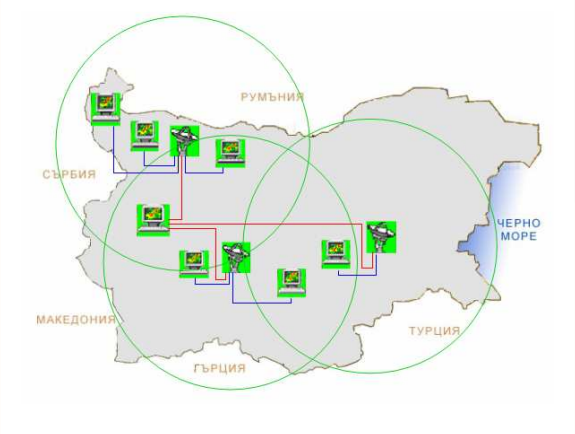
Good practice

Extreme weather risks in Bulgaria: hail-storms

The geographical location and diverse terrain of Bulgaria characterise it as one of the most hail-stormy countries in Europe. Hail is a weather phenomenon, detrimental to the agricultural crops. In order to cope with this problem Bulgaria has a Hail Suppression Agency.

Hail Suppression Agency

The Bulgarian Hail Suppression Agency was set up in 1968 as a structure of the Ministry of Agriculture. Its structure consists of eight Regional Directorates with nine command posts and adjoining rocket launching sites. The first operative anti-hail unit was set up in the town of Saedinenie, District of Plovdiv, in 1969. The Bulgarian Hail Suppression Agency now protects an area of 17 000 sq. km in the regions where hail damages have turned out to be the strongest: the regions of Vidin, Montana, Vratsa, Pleven, Pazardjik, Plovdiv, Stara Zagora and Sliven.



The Agency carries out its activities by monitoring the weather conditions using MRL5-IRIS Doppler radars and cloud seeding. Real time meteorological radar information is transferred to the National Civil Protection Service and the Air-Force.

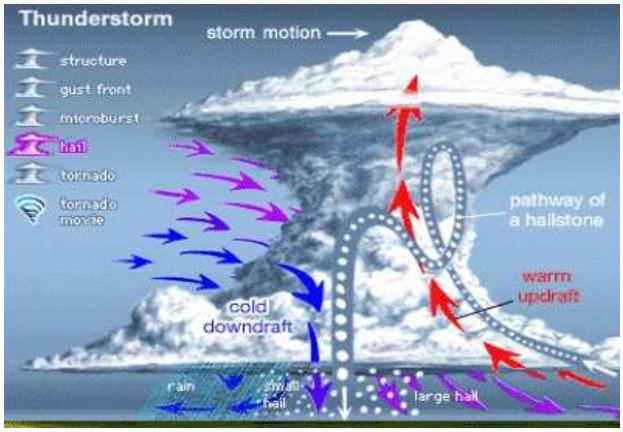
Formation of hails

For the hail precipitation formation, the following conditions are necessary:

- High supercooled liquid water content in the cloud
- Hail embryos: small frozen raindrops or soft ice particles known as grauple, which are hardened conglomerates of snow crystals.
- Strong updrafts.

The formation and the growth of hailstones takes place in the supecooled part of the cloud. As the equilibrium vapor pressure over the water is greater than the saturation vapor pressure over the ice, at the same temperature, the liquid water evaporates and the vapor diffuses onto the ice crystals and they grow more rapidly than droplets (Bergeon-Findeisen process). The further growth of ice crystals to hailstones is as a result of the collision and coalescence of ice particles and water droplets. The strong updrafts ensure long lifetime of the hailstones in the cloud, which reach to large sizes. When the hailstones become too large, they overcome the updrafts and fall to the ground. The hailstones begin to melt in the layer with a temperature higher than 0°C, but they fail to melt fully and reach to ground.

This project is cofinanced by the ERDF and made possible by the INTERREG IVC programme.



In order to prevent hail damages, it is necessary to transform the dangerous convective clouds so as not to allow the formation of large hailstones. Usually, the number of ice crystals in the cloud is small and, upon the existence of appropriate conditions, they grow rapidly to hailstones with large sizes.

Seeding increases significantly the ice embryos concentration so that the artificial and natural ice particles compete with each other for available liquid water. The supercooled water redistributes between all ice embryos and thus resulting hailstones are small. Falling to the ground, they melt to rain or sleet – this is called beneficial competition.

Technology in Bulgaria:

In Bulgaria, the method of delivery of reagent - artificial ice-forming nucleus (AgI) in clouds by rockets has been adopted.

It enables the direct and continuous dispersion of reagent in seeding cloud areas.

The hail suppression concepts define: the seeding areas – the ones with high supercooled liquid water content and weak updraft and the start of seeding – the early stage of development of hail dangerous clouds.

The strong updrafts provide new quantities of supercooled liquid water and carry up the ice crystals to its upper part (anvil). That is why, it is necessary to introduce ice-forming nuclei at regular intervals during the whole period of hail danger.

The effect of hail suppression activity reduces when the hail dangerous cloud comes to the protected area in a mature stage of development. The already formed hail falls to the ground. In these cases, cloud seeding reduces the further intensity of the process and the damages to agricultural crops.

The independent valuation of hail damages to the agricultural crops is made after every cloud seeding activity.

The overall hail suppression activity in Bulgaria is carried out by the RAPIRA system. The system is designed to process and display the weather radar information from MRL5-IRIS, to process the aerological sounding data, to command and control the cloud seeding with seeding reagent and to command the anti-hail rockets launching. The system includes three MRL5-IRIS radar stations, located in the regional directorates. MRL5-IRIS is a modern Doppler radar system for automatic volumetric scanning of the atmosphere and data archiving.

Real time volumetric radar information is transmitted to other command posts and the information centre in Sofia. The information received from the three radars is processed in real time and transmitted to users.

Steps:

1. MRL5-IRIS –Display - The visualisation of cloud systems and selection of hail-dangerous cells is based on the volume radar information from the Doppler radars. The structure of convective clouds, the hail dangerous degree, the location of the seeding area, the beginning and the end of the hail suppression activity are determined by vertical cross-sections on a chosen cross-section line.

The heights of the areas with different radar reflectivity, the location of the seeding area and its radius are transferred to the FIRE HAIL module.

2. Fire H - Aerological sounding - The specialized software ensures: the calculation of the thermodynamic characteristics of the atmosphere by a one-dimensional model with

Microphysics parameterization, necessary for analysis of the atmospheric conditions and cloud characteristics, forecasting of hail and calculating of the diffusion cloud of the reagent.

3. Fire H - Aerosol cloud - The software calculates the volume of the area of reagent diffusion with a definite concentration of ice-forming nuclei. The elevation of the rocket sites for different altitudes.

4. Fire H - Recommendation for firing - The preparation of the data for cloud seeding is made on the basis of the calculations of the atmospheric thermodynamic characteristics and volumes of the areas of reagent diffusion. The recommendation for firing (which rocket launching sites are suitable for firing) is made on the basis of the data from the IRIS Display for the purpose of maximum seeding of the defined cloud area. The recommendations are transferred to the FIRE W module.

5. System of fire control Fire W - The communication and information system for fire control is designed on the basis of modern technology. All information from command posts and rocket

launching sites is received and transferred over the telemetric coded channel as it ensures accurate and timely execution of commands, full real time control of the technique state and execution of commands, archiving of the conditions and execution of the commands.

Lessons learnt

The geographical location and diverse terrain of Bulgaria characterise it as one of the most hail-stormy countries in Europe and we need some measure to save crops. In 2010 only in two Bulgarian regions, the system saved crops for 150 million euro.

- The method proved its effectiveness for more than 40 years.
- Preliminary research and analysis where to place the radar stations and the anti-hail rocket launches in order to have best results for protection of the agricultural crops.
- Expensive method in terms of administration involved

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The MiSRaR project

The MiSRaR project is about Mitigation of Spatial Relevant Risks in European Regions and Towns. The project is a cooperation between seven partners in six EU member states:

- *the Safety Region South-Holland South, The Netherlands (lead partner)*
- *the city of Tallinn, Estonia*
- *the region of Epirus, Greece*
- *the province of Forlì-Cesena, Italy*
- *the municipality of Aveiro, Portugal*
- *the municipality of Mirandela, Portugal*
- *the Euro Perspectives Foundation (EPF), Bulgaria.*

The goal of the project is to exchange knowledge and experiences on risk mitigation in spatial policies. The project will result in a handbook in which the lessons on the mitigation process are described and the good practices from the partners are presented. The Risk Assessment and Mapping Guidelines for Disaster Management of the European Commission will be implemented in the handbook.

The MiSRaR project is cofinanced by the European Regional Development Fund and made possible by the INTERREG IVC programme.

www.misrar.eu

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