Electronic service for providing users with data of hail suppression activities

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Abstract. Database managed by MS Access is intended for automated access to the data of hail suppression activities carried out by the paramilitary services of Roshydromet. The main function of the database is to store information and provide it to network users for carrying out scientific analysis and obtaining reference information. On the base of the collected and processed hailfall data, it is possible to automatically calculate the annual average and maximum number of days with hail in a year, the annual average of hail damaged area reduced to 100% loss, the annual average percentage of crop losses and annual hail damage. This information will help specialists study hailstorm development more in detail, including in particular categories of seeding targets, number of expended rockets, and evaluate the effectiveness of the cloud seeding operations, taking into account the accumulated operational data.

1. Introduction
Hail protection on the territory of the Russian Federation is carried out by three Paramilitary Services of Roshydromet (Krasnodar Service, Stavropol Service and North Caucasian Service). The protected areas of the Russian Federation are located in the Krasnodar and Stavropol Krai and also in the republics of Karachay-Cherkessia, Adygea, North Ossetia-Alania and Kabardino-Balkaria, and occupy 2.655 million hectares.

Based on the results of the preparation and carrying out of hail suppression operations, the Hail Suppression Services of Roshydromet send data on seeding operations to the FSBI «HMGII», that are electronic copies of documents elaborated by Hail Suppression Services during the campaign (telegrams, operation records, inspection reports, updates, brief, monthly and annual reports).

Data of weather radar stations, meteorological stations and other departments are the main sources of information on hailfall events. In the areas located between observation points (meteorological stations), the additional sources of information on hailfall events are insurance companies data and information of owners of agricultural land affected be hail and eyewitnesses of the event, as well as the data of meteorological radars MRL-5 network and agricultural authorities [1].

Actual development of meteorological science is associated with automated technologies for collecting and storing a large amount of heterogeneous information with its subsequent systematization and analysis [2, 3].
2. Methodology and data

Object of research of present work is the database used to replenish the information resources of Roshydromet with hail suppression activities data and to develop electronic services for different classes of information consumers.

Over the many years of operation of the hail suppression services of Roshydromet, extensive data of hail suppression operation carried out in the territory of the Russian Federation has been accumulated and it was necessary to systematize it logically for electronic services, providing different classes of users with hail suppression activities data. In this regard, the MS Access electronic database for purpose of replenishment of Roshydromet information resources with hail suppression operations data was created in the FSBI «HMGI» [4]. The main function of the database is to improve the storage quality, transmission and use of cloud seeding data, including radar observation data, fragments of hail suppression operations, rockets expenditure, areas of hail impact and hail damage data, and provide the data above to network users for carrying out scientific analysis and obtaining reference information.

Beyond that, the database «Hail suppression operations data» performs the task of organizing the accounting data and documents related to hail suppression operations during the operational campaign of the Paramilitary Services.

The primary data for replenishing the database are data of hail suppression operations, that are the electronic copies of documents (telegrams, operation records, inspection reports, updates, brief, monthly and annual reports), received during the campaign from the paramilitary hail suppression services of Roshydromet, based on the results of the preparation and carrying out of hail suppression operations [5].

![Database structure and relationships between tables.](image-url)
The main parameters describing a hail suppression operation during the campaign (by dates) are:

- description of hailstorm (date and seeding time, hailstorm type, precipitation type, precipitation characteristics by areas of falling);
- number of seeding targets (total number and number by category);
- number of rockets expended by the Service and rockets remaining in the Service;
- crop damage area (ha);
- area of crop damage reduced to 100% loss (ha);
- total prevented damage from rapid damage assessment data, in RUB MM, on given date.

Figure 1 shows the structure of the infological and datalogical database model.

All tables with data (figure 1) (daily.data, daily.docs, yearly.data, yearly.docs) are linked to the table with subordinate Hail Suppression Services (admin.dependence) in the duty field. The type of all relationships is many-to-one.

The list of users (admin.users) is linked to the table of user rights (admin.rights) in the login field (one-to-many relationship type) and to the contact data table (admin.contacts) in the details field (communication type «one-to-one»).

In order to provide users with hail suppression operations data by means of electronic service, an interface connected to the database via an http-server was developed. The remote access to the database «Hail suppression activities data» and the viewing materials of seeding operation is available at the address http://37.18.105.76/av/ with entering username and password. Examples of viewing information are presented in the figures 2 and 3.

### Seeding operation characteristics

| Seeding time       | Operation date |
|--------------------|---------------|
| Start 16:15        | 02.05.2019    |
| Finish 17:10       |               |

### Damage characteristics

| Description       |
|-------------------|
| Hailstone diameter | 1.5 cm         |

### Seeding operations data

| Seeding operation characteristics | Service annual performance |
|-----------------------------------|---------------------------|
| Operation data                    | Operation date            |
| Area of crop damage, ha           | 2472                      |
| Area of crop damage reduced to 100% loss, ha | 1280       |
| Target area with damage           |                           |
| Total prevented damage from rapid damage assessment data, in RUB MM, on given date | Environment |
| Rockets expenditure              |                           |
| Anti-hail rockets                 | 117                       |
| Rockets remaining in the Service on | 01.03.2019               |
| Rockets remaining in the Service, units | 0797        |

Figure 2. Example of remote access to attached documents of the Krasnodar Hail Suppression Service dated 02.05.2019.
Seeding operations data

| Seeding operation characteristics | Service annual performance |
|----------------------------------|---------------------------|
| Hail suppression service          | Service annual performance |
|                                   | Year                      |
|                                  | 2019                      |
|                                  | Data request              |
| Campaign start date               | 01-04-2019                |
| Campaign finish date              | 20-10-2019                |
| Hail hazard coefficient           | 0.9                       |
| Total of days with seeding       | 25                        |
| operations                       |                           |
| Operational days with damage     | 0                         |
| Operational days without damage  | 25                        |
| Total target area, in thousands   | 921                       |
| ha                               |                           |
| Agricultural land area, in        | 616                       |
| thousands ha                      |                           |
| Crop damage area, in thousands    | 0                         |
| Area of crop damage reduced to    | 0                         |
| 100% loss, ha                    |                           |
| Physical effectiveness           | 100                       |
| Economic efficiency, in RUB MM    | 768                       |
| Total number of seeding targets   | 132                       |
| Targets of 1st category          | 1                         |
| Targets of 2nd category          | 32                        |
| Targets of 3rd category          | 59                        |
| Targets of 4th category          | 0                         |
| Number of expended rockets        | 1384                      |
| Rocket stock at year-end         | 1468                      |

**Figure 3.** Example of remote access to attached documents of the operational campaign of the North Caucasian Hail Suppression Service.

An assessment of the hail hazard of different territories with a view to determining the worthwhileness of hail protection service deployment is carried out on the basis of data on annual average of days with hail, annual average of crop damage area reduced to 100% loss (ha), annual average damage from hail. The area of damage to crops and the area of hail damage reduced to 100% crop loss are determined according to RD 52.37.732-2010 [6]. The data of radar observations related to the crop damage area are verified by inspecting the fields impacted by hail.

Rapid damage assessment of the prevented damage during the hail suppression campaign is carried out on the basis of the data on the number of seeding targets of different category on one operational day.

3. Conclusions

- Collected data can be used for integrated studies of the macro- and microstructural characteristics of hail clouds and precipitation.
- Meteorological and physical parameters of hailstorms (hail size, crop damage area, etc.) can be used to assess the physical effectiveness and economic efficiency of the hail suppression activities and the effect achieved statistical significance.
- Developed technology can be implemented into the practice of the hail suppression paramilitary services and the network organizations of Roshydromet.
References

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