

DEGREE AND AREAS OF DAMAGE CAUSED BY HAIL IN THE TERRITORY OF KAKHETI REGION (GEORGIA)

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Abstract

Hail belongs to such a dangerous meteorological phenomenon that causes great damage to the economies of countries. Heavy hail is frequent in Georgia, in its eastern part. The region of Kakheti is particularly notable, where heavy hail causes millions of losses every year, especially in the agricultural sector. Therefore, it is important to determine the agricultural areas affected and the degree of damage caused.

The data of 2016-2019 have been processed, which includes data on the total damaged areas of Kakheti region, including 100% damaged areas, as well as averaged data on the degree of damage in percentages and data on the types of damaged agrarian culture. The distribution of damaged areas and degree of damage in Kakheti region according to municipalities is shown. Areas with particularly high degree of damage and areas to be covered have been determined.

Keywords: Hail, Natural disaster, Meteorological phenomena, Climate, damaged area

INTRODUCTION

Hail causes great damage to the economies of countries and especially to agriculture. Often, intense hail leads to the complete destruction of agricultural fields, the death of livestock, and sometimes even poses a threat to human life. Hail is common in most regions of the world, it causes great problems in many countries of the world - Italy, France, the United States of America, Russia, Moldova, Australia, Hungary, Poland, China, Argentina, the countries of the Caucasus and Central Asia, etc. Annual global losses of agricultural products from hail damage range from 4 to 18% of the crop, and in monetary terms exceed 11 billion US dollars <https://www.meteorf.ru/activity/activ/antigrad/obs-info/> [1]. Hail is especially dangerous in those areas (including Georgia) that are characterized by complex terrain, high altitudes above sea level, high humidity of air masses, as well as high temperatures of the earth's surface, which contributes to increased convection [1-4].

The extent of damage caused by hail depends on the size of the hailstones that fall. Agricultural crops are severely damaged by small, intense hail, but hailstones with a diameter of 10-15 mm are especially dangerous, and hailstones with a diameter of 30-40 mm or more can destroy crops, shoot through the roofs of houses, break windows, kill poultry and small goods. Rare cases of hail, when hailstones weighing 100-200 g and the size of a chicken egg, can cause death [<https://www.torro.org.uk/research/hail/hscale/>; 5]. Georgia is characterized by small intense hail in most cases - about 70%; The repeatability of hailstones of medium (20-30 mm) and large (30 mm or more) diameter is 25-30%. In addition, the frequency of hailstones with a diameter (30-50 mm) in Georgia is 10%, and finally, 4% of hailstones are caused by the arrival of hailstones with a diameter of 50 mm or more [6,7].

Hail research in Georgia has a long history. A large amount of literature is devoted to the problem of hail in Georgia. Research conducted in this direction includes a wide range of hail climatology [2,4], as well as the study of the mechanism of hail formation [8], the methods and results of the impact on hail processes [9], hail damage assessments [3,5,7, 10-16] etc.

This paper examines hail events in 2016-2019. The extent of damage caused by hail in Kakheti is being discussed. The areas damaged by hail have been studied, both in general and 100% affected. A list of

agricultural crops damaged by hail is provided for the relevant municipalities. The results of hail damage on the territory of Kakheti for the four-year period under study (2016-2019) were analyzed.

STUDY AREA, MATERIALS AND METHODS

Study area

Kakheti region of Georgia and its individual municipalities: Gurjaani, Kvareli, Signagi, Telavi, Sagarejo, Lagodekhi, Akhmeta, and Dedoplistskaro. Kakheti is the eastern border region of Georgia, bordering the Russian Federation in the north and Azerbaijan in the south. The total area of the region is 11309.5 km². There are 9 cities and 276 villages in the region, the administrative center is Telavi (41.75° north latitude, 45.72° east longitude). Agriculture plays a predominant role in the region's economy. Wherein, Kakheti is the country's leading wine region, producing almost three-quarters of the country's wine grapes, which are grown on lands that have been used for viticulture for thousands of years. Therefore, problems associated with hail processes are always relevant for this region, including hail climatology, the development of active and passive methods of protection against it, assessment of possible damage from hail, planning the expansion of agricultural land considering hail hazard, etc.

Materials

The work used data on hail-damaged areas were obtained during the inspection by special commissions of Kakheti municipalities and materials from the anti-hail service about hail processes.

In the work data on the total area damaged by hail, including 100% of the damaged area. Materials on damage in percentage and types of damaged agriculture crops were also used. The period of investigation - 2016-2019. The total number of hail damages agricultural localities is 112 and total number days with hailstorm – 48.

Methods

For the data analysis the standard statistical methods are used.

RESULTS

Results in Fig. 1-3 and Table 1,2 clearly are presented.



Figure 1. Mean annual hail damage areas in Kakheti by municipal educations in 2016-2019, ha.

On top - total area of damage; on the right - 100% damaged area.

In Fig. 1 data on mean annual hail damage areas in Kakheti by municipal educations are presented. As follows from this Figure mean annual total area of hail damage change from 148 ha (Dedoplistskaro) to 1917 ha (Gurjaani) and mean annual 100% damaged area – from 35 ha (Dedoplistskaro) to 909 ha (Sagarejo).

Note: the total hail damage area in Kakheti in 2016-2019 is 28580 ha, and total 100% hail damage area – 12277 ha.

In Table 1 data on number of agricultural localities, number days with hailstorm and average degree of damage area in Kakheti are presented.

Table 1. Number of localities, number days with hailstorm and average degree of damage area in Kakheti.

Municipality	Number of localities	Number days with hailstorm	Degree of damage, %	Agricultural species
Gurjaani	23	18	36.4	Vineyard, stone fruit, annual crops, fruit trees, and others
Kvareli	13	12	41.5	Vineyard, fruit trees, melon crops, nut, private plots and others
Signagi	18	12	46.1	Vineyard, grain, wheat, barley, vegetables, fruit trees private plots and others
Telavi	11	9	47.4	Vineyard, private plots and others
Sagarejo	23	13	48.2	Vineyard, wheat, barley, corn, sunflower, beans, melon crops, vegetables, pumpkins, watermelons, fall crops, fruit trees, peaches, peanuts, hazelnut orchards, private plots and others
Lagodekhi	9	4	32.1	Vineyard, melon crops, , fruit trees, perennial nuts, persimmons, autumn vegetables private plots and others
Akhmeta	10	5	55.5	Vineyard, melon crops, fruit trees, private plots and others
Dedoplistskaro	5	3	23.8	Vineyard, private plots and others

The greatest number of localities with hail damage in Gurjaani and Sagarejo are observed (23 localities in each municipality), the smallest – in Dedoplistskaro (5 localities). Number days with hailstorm change from 18 (Gurjaani) to 3 (Dedoplistskaro). Mean degree of hail damage change from 23.8% (Dedoplistskaro) to 55.5% (Akhmeta).

In Figure 2 information about average values of areas damaged by hail on the territory of Kakheti during one day with hailstorm are presented.

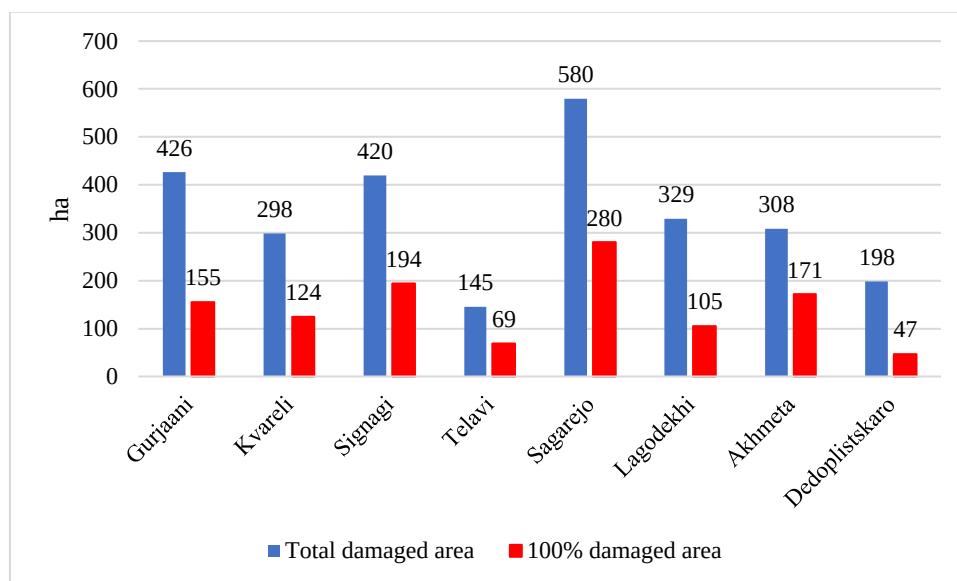


Figure 2. Average values of areas damaged by hail on the territory of Kakheti during one day with hailstorm.

As can be seen from Figure 2, the min average total damaged area during one day with hailstorm on the territory of Telavi municipality is observed (145 ha) and the max – in Sagarejo municipality (580 ha). The min average 100% damaged area during one day with hailstorm on the territory of Dedoplistskaro municipality is observed (47 ha) and the max – in Sagarejo municipality (280 ha).

Figure 3 shown data on the average area affected by hail damage in Kakheti to one locality.

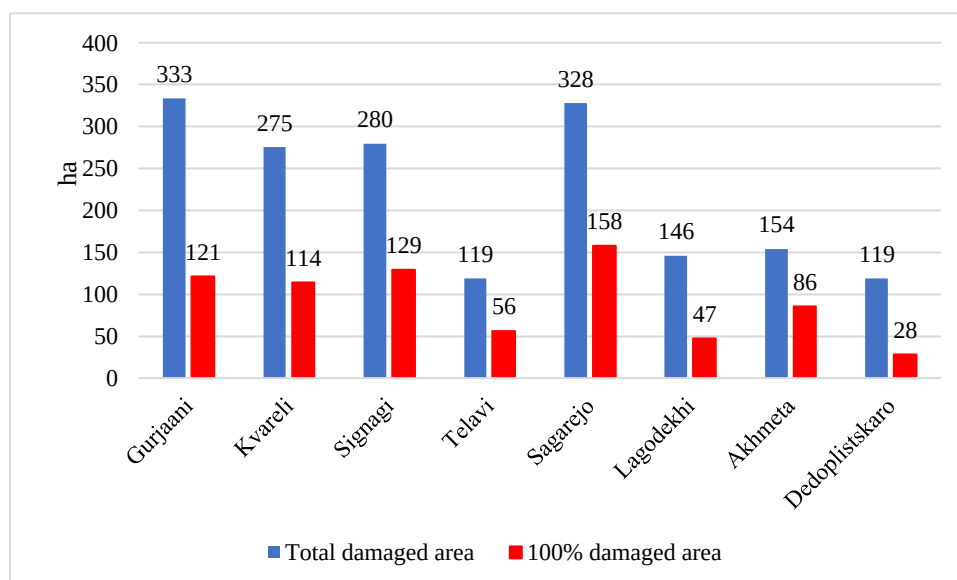


Figure 3. Average area affected by hail damage in Kakheti to one locality.

As follows from Figure 3 average area affected by hail damage in to one locality change from 119 ha (Dedoplistskaro) to 333 ha (Gurjaani) and 100% hail damage area – from 28 ha (Dedoplistskaro) to 158 ha (Sagarejo).

Table 2 present data about some characteristics of hail damage in Kakheti during to one locality.

Table 2. Characteristics of hail damage in Kakheti during to one locality.

Municipality	Min damage to one locality, ha	Min 100% damage to one locality, ha	Max damage to one locality, ha	Max 100% damage to one locality, ha	Min degree of damage to one locality, %	Max degree of damage to one locality, %
Gurjaani	0.6	0.2	1400	460	12.3	59.1
Kvareli	30.0	6.8	935	450	20.0	52.5
Signagi	10.0	0.7	826	482	6.5	75.0
Telavi	10.0	1.3	570	349	9.5	65.0
Sagarejo	8.0	3.0	1100	719	7.5	81.7
Lagodekhi	10.0	3.8	465	115	15.0	65.0
Akhmeta	7.0	5.0	410	276	20.0	95.0
Dedoplistskaro	20.0	11.3	233	52	22.5	60.0

The range of variability of these characteristics is as follows.

- Min hail damage to one locality: from 0.6 ha (Gurjaani) to 30 ha (Kvareli).
- Min 100% hail damage to one locality: from 0.2 ha (Gurjaani) to 11.3 ha (Dedoplistskaro).
- Max hail damage to one locality: from 233 ha (Dedoplistskaro) to 1400 ha (Gurjaani).
- Max 100% hail damage to one locality: from 52 ha (Dedoplistskaro) to 719 (Sagarejo).
- Min hail degree of damage to one locality: from 6.5% (Signagi) to 22.5% (Dedoplistskaro).
- Max degree of damage to one locality: from 52.5% (Kvareli) to 95.0% (Akhmeta).

Note: the mean values of areas damaged by hail on the territory of Kakheti during one day with hailstorm is 595 ha and 100% damaged area – 256 ha; the mean values of areas damaged by hail on the territory of one locality of Kakheti is 255 ha and 100% damaged area – 110 ha; the mean degree of hail damage is 43.0%.

CONCLUSIONS

Based on the research conducted, it can be concluded that the Gurjaani municipality stand out in the Kakheti region, where mean annual total area of hail damage is 1917 ha and Sagarejo municipality where mean annual 100% area of hail damage is 909 ha. The total hail damage area in Kakheti in 2016-2019 is 28580 ha, and total 100% hail damage area – 12277 ha. The mean degree of hail damage is 43.0%.

The average total and 100% damaged area during one day with hailstorm on the territory of Sagarejo municipality is observed (580 and 280 ha respectively).

Max total hail damage area to one agricultural locality in Gurjaani municipality is observed (1400 ha), and 100% damage area to one agricultural locality in Sagarejo municipality - 719 ha.

Thus, during the study period, the agricultural areas most affected by hail were observed in the municipalities of Gurjaani and Sagarejo of the Kakheti region of Georgia.

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