INTENSITY OF HAILSTORM IN KAKHETI REGION IN GEORGIA

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Abstract

Kakheti region is one of the hail risk regions in Georgia. It is particularly noteworthy that Kakheti is famous for its agricultural crops, vineyards, gardens, annual and perennial crops. In the warm period of the year, there are frequent hailstorms, which destroy the crops and thus cause great damage to both the region and the country's economy. In many cases, the intensity of hail determines the amount of damage - the greater the intensity, the greater the damage.

The purpose of the study is to determine the intensity of hail for the Kakheti region, which is the subject of our special interest, since intense hail damages this region the most. Average and maximum intensities of hail were estimated based on available data. Areas of intense hail were defined according to different intensities. Tables of average and maximum intensity of hail and corresponding geo-informational maps were compiled.

The research was carried out according to the data of 10 meteorological stations in the Kakheti region, which includes both the last century (1983-1991) and 2014-2018 data on hail.

The obtained results will contribute to the planning and implementation of anti-hail works in the Kakheti region.

Keywords: *Hail, Meteorological phenomena, Climate, Anthropogenic impact*

INTRODUCTION

In terms of hail activity in the territory of Georgia, the regions are very different from each other. One of these distinctive regions is Kakheti, which occupies the extreme eastern part of Georgia. Unlike other regions, it is the most affected by hail. [1,8].

The destructive effects of hail in Kakheti have been extensively documented. A hailstorm that fell in Sagarejo on June 19, 1953, for example, formed a raid 5-7 cm thick. Orchards and vineyards were damaged. Heavy hailstones as large as walnuts hit Telavi and Gurjaani on July 19, 2012, at midnight. Buildings were damaged, crops were destroyed. And the plants had no leaves by dawn. Human casualties would be inevitable if this occurred during the day. There were numerous instances of similar occasion during and after the same year.[9].

The following table 1 shows cases in Kakheti where large areas were damaged by severe hail.

Table 1. Heavy hailstorms in Kakheti (1877-2012)

Year	Month	Number	Damaged area km^2	Affected areas, the center of greatest intensity
1877	July	4	60	Gurjaani, Vejini, Bakurtsikhe
1953	June	19	45	Sagarejo
1978	May	28	129	Signagi
1982	May	20	34	Gurjaani, Dedoplitskaro

1986	May	21	30	Gurjaani, Ruispiri
1987	May	9	121	Udabno, Nukriani
1987	May	12	42	Napareuli
1987	June	4	18	Gavazi
2012	July	19	35	Telavi

Based on table 1, the largest areas were affected by heavy hail on May 28, 1978, in Sighnagi (129km^2) followed by Udabno and Nukryan (121km^2) on May 9, 1978.

The Kakheti region includes the valley of the Alazni River and part of the plateau of the Iori River, bounded by the Caucasus Range in the northeast, Kakheti Range in the northwest, and the Tsivgombor Range in the west and southwest. Convective processes here are often associated with western invasions and less often with eastern invasions. These processes tend to emerge in the presence of a cold front, particularly during May and June. According to long-term data from meteorological stations, the average number of days with heavy hailstorms in the region is more than 3 per year. There is a high recurrence of 70% in established and unsteady hail processes, with only 9% passing through the cellular stage. However, the damage caused by the latter is significant and can reach 80%[10,11].

Most of the hail processes originate outside of Kakheti, hail clouds move along the Gombori Range, which is filled with warm moist air masses from the lower atmosphere, which causes increased hail, then reach the depths of the Alazani valley and cover the Alazani valley and part of the Iori plateau.

Air masses entering the Alazni basin from both sides, from the west and east, cause not only heavy rainfall, but also frequent lightning and hail during the warm season, which causes great damage to agriculture in the Kakheti region[12,13].

Table 2 below gives a general description of some of the meteorological elements in the Alazni Basin.

Table 2. Average annual data for some meteorological elements of the plains and foothills of the Alazani River

meteorological station	Altitude above sea level	Average annual atmospheric precipitation mm.	Average annual air temperature	absolute minimum temperature	Absolute maximum temperature
Signagi	795	811	11.1	-24	37
Telavi	568	776	12.1	-23	39
Alazani	567	739	12.0	-23	38
Lagodekhi	435	975	12.9	-23	38
Gurjaani	415	783	12.6	-22	38
Alazani	290	804	13.7	-24	40
Jokolo	663	1207	10.8	-26	38

As can be seen from Table 2, the plains and foothills of the Alazani depression receive a significant amount of precipitation, but they are unevenly distributed throughout the year. And the average annual air temperature usually decreases with altitude. The coldest month is January and the hottest month is July and August.

MATERIALS AND METHODS

Materials

The study used materials from the National Environment Agency on hail in Kakheti, including data from 10 meteorological stations in the region on the number of days with hail, duration and area of hail, mainly data from 1983-1991. and 2014-2018 We also used historical data taken from climate reference books and literature describing the results of severe hailstorms recorded in different periods[14,..18].

Methods

These studies were carried out using methods from mathematical statistics and probability theory, which are widely accepted in climatology. And also using methodological principles developed by the Atmospheric Physics Sector of M. Nodia Institute of Geophysics.

RESULTS

The intensity of the hail mainly depends on the size of the hail and the duration of the hail. The diameter of hailstones varies widely, from a few millimeters to several centimeters. According to V. Gigineishvili[19], the maximum diameter of hailstones recorded in eastern Georgia is 4-5 cm, hailstones with a diameter of 1.4-1.8 cm mainly fall in the Alazani Valley in eastern Georgia. G. Sulakvelidze[22] cites the facts about the hail that fell on the North Caucasus, according to which the diameter of the hailstones was 8 cm. The larger the size of the hailstones, the greater the effect of their impact. for example, hailstones with a diameter of 5 cm or more have a very strong and catastrophic effect. As the size of the hailstones decreases, the impact effect decreases, and the impact effect of grains with a diameter of 5 mm is rather weak. Neither the Georgian Hydrometeorological Service nor the National Environment Agency conducted standard observations of the diameter of hailstones this time, so the hail intensity was estimated based on the damage area. When classifying the hail intensity, the size of the hail was considered[1] (Table 3.).

Table 3. Hail intensity, possible damage and expected losses

Intensity in points	Hailstone diameter in mm.	100% affected area km^2.	Impact effect	Possible damage and loss
1	≤5	<1	very weak	Crops and leaves of trees are partially damaged.
2	6-10	1-5	weak	Orchards, vineyards, crops are visibly damaged.
3	11-20	6-10	average	Greenhouses and windows of buildings and vehicles were damaged, the roofs of buildings were damaged, orchards, vineyards and crops were damaged.
4	21-50	11-50	strong	Crops were completely destroyed, roofs of houses collapsed, windows of buildings and vehicles were smashed out, poultry and livestock were killed, the walls of brick buildings were damaged, and there is a risk of damage to light aircraft.

5	>50	>50	very strong	Agricultural crops and pastures have been completely destroyed. Destroyed wooden buildings. brick buildings, aircraft and automobile hulls were badly damaged. the roofs of some buildings were destroyed. Pets are dying, there is a risk of human casualties.

It should be noted that this scale of city formation is rather general. If hail is accompanied by strong winds and thunderstorms, the degree of damage to crops, buildings and vehicles is much higher. At this point, even small hailstones, such as those characteristic of 1-2 points (not to mention falling larger hailstones), can cause the same damage as hailstones of 3 or more points. Large hailstones, combined with strong winds and thunderstorms, can cause catastrophic consequences of both economic and humanitarian nature (destruction of residential buildings, vehicles, power lines, death of poultry and animals, human casualties, etc.). More severe consequences can occur if these processes are accompanied by intense heavy rains, which, together with the above phenomena, lead to floods, landslides, and mudflows [23].

For a long time, there has been no recorded data on hail intensity in Georgia. The average and maximum hail intensities for Kakheti were prepared (Table 3.) based on the research and analysis of the materials we obtained, which included data on town formation intensity during 1983-1991, and following 2014-2018 years.

Table 4. Average and maximum intensity of hail in Kakheti by municipalities

Municipalities	Average intensity (point)	Maximum intensity (point)
Akhmeta	2.6	5
Telavi	2.0	5
Sagarejo	2.2	5
Gurjaani	2.5	5
Dedoplistskaro	1.6	3
Lagodekhi	1.7	4
Kvareli	2.8	5
Sighnaghi	2.3	5

Table 4 clearly shows that a relatively low hail intensity in Kakheti is observed only in Dedoplistskaro and Lagodekhi districts, on average 1.6 and 1.7 points, while in the rest of Kakheti the average hail intensity is in the range of 2-3 points. A similar situation is in the case of the maximum intensity of hail, in all districts of Kakheti, except for Dedoplistskaro and Lagodekhi district, the maximum intensity of hail was recorded - 5 points, which was also expected.

In Kakheti, the highest hail activity in 2014-2018 was registered in the municipalities of Telavi (17 days with hail in 38 locations) and the Gurjaani municipality (16 days with hail in 43 locations), the lowest - in the municipality of Dedoplistskaro (2 days with hail in 2 locations). Duration of hail in Kakheti in 2014-2018 ranges from 5 to 30 minutes, and the diameter of the hailstones during this period was 6-23 mm[24].

Based on the table. 4, geoinformation maps of average and maximum hail intensity for the municipalities of Kakheti are compiled (Fig. 1 and 2).

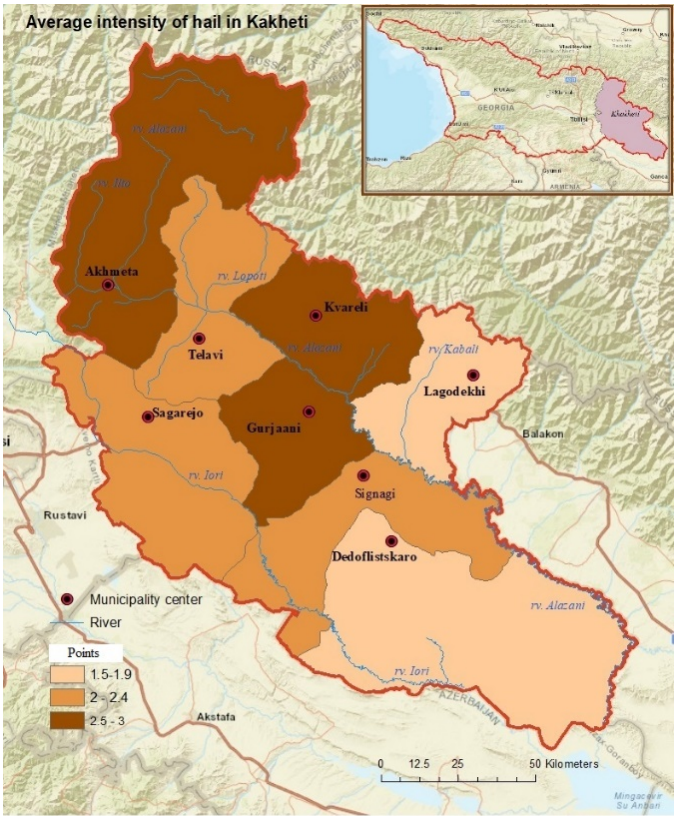

Fig. 1. Average intensity of hail in Kakheti by municipalities

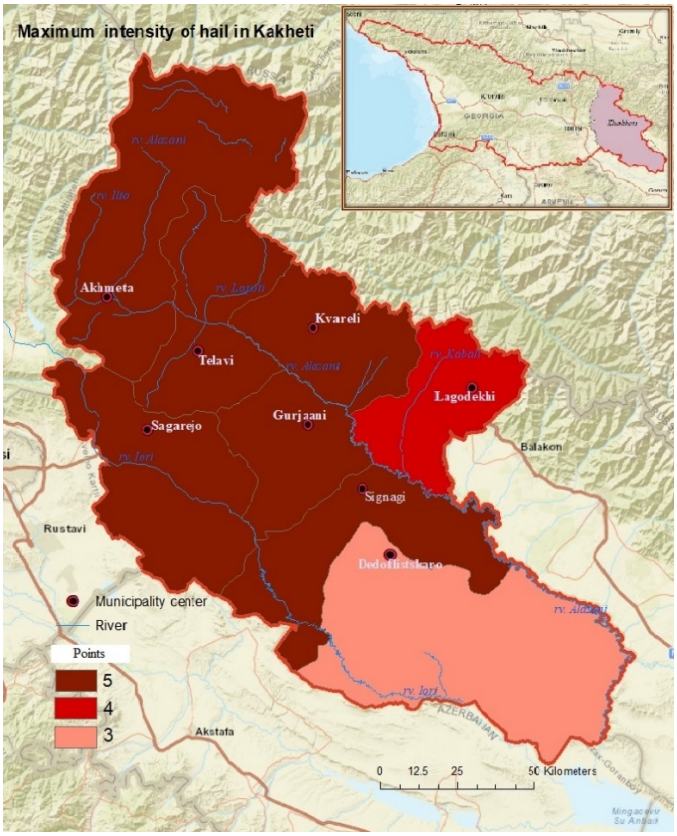

Fig. 2. Maximum intensity of hail in Kakheti by municipalities

Analysis of fig. 1 and 2 shows that the highest average hail intensity (2.5-3) points was registered in three municipalities of the Kakheti region, namely: Akhmeta, Gurjaani and Kvareli. The highest indicator of maximum hail intensity of 5 points, as already mentioned, is observed in 6 out of 8 municipalities, with the exception of the municipalities of Lagodekhi and Dedoplistskaro. Such results once again confirm that most of Kakheti is under the influence of high-intensity hail.

It should be noted that an increase in anthropogenic pollution of the atmosphere has a significant impact on the dynamics of hail processes and an increase in their intensity. Convective clouds entering the Kakheti region are polluted with anthropogenic aerosols when passing through the regions of Gardabani - Rustavi - Tbilisi - Kaspi, due to this, frontal convective clouds from Kakheti and its outskirts are filled with anthropogenic crystallization centers, which affects the activity of lightning and hail clouds. [25,..27]

CONCLUSIONS

Intense hail will be observed in the entire territory of Kakheti region;

According to the developed scale for determining the intensity of hail, catastrophic hail - with an intensity of 5 or more points, is observed in 11% of cases of hail in Kakheti;

The municipalities of Akhmeta, Gurjaani and Kvarli stand out, where the average intensity of hail is 2.5-3 points according to the scale, which is the highest indicator in the region.

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