Journal of the Georgian Geophysical Society, e-ISSN: 2667-9973, p-ISSN: 1512-1127
Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v. 27(1), 2024, pp. 67 - 76

Some Results of an Expeditionary Study of the Tornado Distribution Area in Kakheti on June 25, 2024

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ABSTRACT

Some results of an expeditionary study of the tornado distribution area in Kakheti on June 25, 2024 are presented. The team of researchers visiting the Alaverdi Cathedral, had a meeting with His Eminence, Bishop of Alaverdi, Metropolitan David. The damage to the Alaverdi Cathedral and its surroundings was discussed in detail. Important information has been received regarding this issue. Further research was continued in the area surrounding the Alaverdi Cathedral and in the direction of the villages of Kvemo and Zemo Alvani. The probable place of origin of the tornado and the trajectory and area of its spread were determined. The damage caused by the tornado on the propagation trajectory was studied. More detailed studies of this natural phenomenon are planned in the near future.

Key words: *natural disasters, hurricane winds, tornadoes, distribution area, damage to facilities.*

Introduction

Wind is one of the main climate-forming factors. Georgia is characterized by complex physical-geographical and climatic conditions, as a result of which significant and abrupt changes in a number of meteorological parameters may be observed in certain regions. Therefore, in Georgia, as in other countries, special attention is paid to the study of wind regimes [1-6].

Wind frequency is influenced by local winds, so-called breezes, which cause seasonal and diurnal variations in the wind and cause changes in its regime [1, 3-5]. Research on the wind regime is important for the development of wind energy, the agricultural sector of the economy [3] and other areas. Strong winds often cause damage and destruction of residential and industrial facilities, shutdown of airports, snowstorms, and enhance the negative consequences of other dangerous hydrometeorological phenomena (intense precipitation, hail, etc.), casualties, etc. [7-10]. Wind speed determines the level of air pollution [11,12]. Wind is also one of the most important bioclimatic factors. Therefore, information about the wind regime is important for the development of the economy, resort and tourism sector [13] and for assessing various simple and complex bioclimatic characteristics for specific territories [14, 15].

The assessment of extreme wind values is especially important from the point of view that such phenomena, as a result of their destructive effects, can cause significant damage to the agro-economic and other infrastructure of the country [7,8,16-22]. In particular, article [23] presents information about the tornado in Kobuleti, and also discusses the issue of a more detailed study of these events in Georgia.

In the study [24], as a special case, considered a tornado that took place on September 25, 2021 in the terminal space of the city of Poti, which caused significant damage to one of the cargo terminals.

To assess the specified damage, photographic materials were used, filmed in automatic mode by video cameras of the surveillance system located on the territory of the terminal. With the help of these data, it was possible to estimate the speed of the vortex flows of the above spontaneous process (tornado). To determine the speed of movement of objects inside the tornado, the deceleration program "Mivavi Video Editor Plus" was used.

As a result of subsequent processing of the received video image, it was found that at one of the points in time, the speed of objects inside the tornado was 190 - 265 km/h. According to the so-called Fujita scale, the strength of a tornado is determined by the wind speed inside the tornado and related phenomena

(degree of destruction). As a result, it was found that the strength of the tornado in the considered territory of the terminal corresponds to the F2 value of the Fujita scale, which was due to the specifics of the location of the territory and the synoptic processes recorded in the considered period of time.

In this work some results of an expeditionary study of the tornado distribution area in Kakheti on June 25, 2024 are presented.

Study area, material and methods

Study area - Akhmeta municipality of Kakheti region of Georgia (Alaverdi Cathedral and surrounding areas, the villages of Kvemo Alvani and Zemo Alvani). On June 29, 2024, the authors of this article were in the specified area to study the movement of the tornado that developed on June 25, 2024, as well as its impact on the environment. One of the main tasks of the expedition was to identify the approximate location of the tornado formation.

The team of researchers visiting the Alaverdi Cathedral, had a meeting with His Eminence, Bishop of Alaverdi, Metropolitan David. The damage to the Alaverdi Cathedral and its surroundings was discussed in detail. Important information has been received regarding this issue. The team then continued to survey the above areas.

To solve this problem, the following were used: portable, as well as drone-mounted, photo and film equipment; JPS device; population survey; some materials that were posted on the Internet.

Alaverdi - Cathedral and Monastery is located in the Kakheti region of Akhmeta municipality, on Alazani valley, near the village of Alaverdi, 20 km from Telavi (Fig. 1). The temple is one of the largest church buildings in Georgia. Its height including dome is above 50 meters. The complex includes buildings: Alaverdi St. George Cathedral, defensive wall, chapel, Peikar-Khan's palace, wine cellar and bath.

Fig. 1. Alaverdi - Cathedral and Monastery.

Alaverdi Monastery was founded by Joseph Alaverdeli, one of the Assyrian fathers in the middle of the VI century. At the beginning of the XI century, Kvirike the King of Kakheti built a cathedral (which is known by the name of Alaverdi) at the site of the little church of St. George.

Alaverdi was one of the most outstanding chapels of medieval Georgia. Alaverdoba (September-October) was very popular ecclesiastical and public holiday. Which was celebrated not only by Georgians (from Kakheti, Kiziki, Ertso-Tianeti, Pshav-Khevsureti) but Kists And Dagestan people as well. The market was also held [https://georgiantravelguide.com/en/alaverdi].

Some results of the expedition's research are given below.

Results

Results in Table 1-3 and Fig. 2-8 are presented.

In Fig. 2 and Table 1 information about some locations the tornado distribution area in Kakheti on June 25, 2024. Table 1 also provides information on damage to various objects along the tornado's path.

Fig. 2. Some locations the tornado distribution area in Kakheti on June 25, 2024.

Table 1. Coordinates of locations the tornado distribution area in Kakheti according to Fig. 2.

Point N	Lat, °N	Long, °E	H, m, a.s.l.	Comment
0	42.03236	45.37742	446	Center dome of the Cathedral.
1	42.0356	45.38649	437	Agricultural cold storage farm. A large tree branch was broken and part of the building's roof collapsed.
2	42.03584	45.38761	435	To the direction of the tornado movement.
3	42.03664	45.38904	435	To the direction of the tornado movement.
4	42.03538	45.38543	437	Roof remains found.
5	42.0348	45.38156	439	Road to the cold storage farm (behind the Cathedral).
6	42.03424	45.37951	440	Damaged shed roof.
7	42.03395	45.37731	441	A damaged tree behind the Cathedral.
8	42.03405	45.37462	443	Shop between the cathedral and the village Alaverdi.
9	42.03354	45.38095	440	Farm with badly damaged roof next to the Cathedral.
10	42.03321	45.37783	443	Cemetery. Damaged trees and broken tiles. Next to the Cathedral.
11	42.03328	45.37783	443	Cemetery. A possible place where the cross fell.
12	42.03272	45.31199	466	Farm in the Zemo Alvani. Farmer - Chikhoshvili Khvicha.
13	42.02984	45.30888	466	Approximate location of tornado formation.
14	42.03351	45.32413	458	Damaged house under construction at the end of a farm in Zemo Alvani.
15	42.03317	45.32011	461	A heavily damaged farm roof in the path of a tornado.
16	42.03565	45.31116	467	The temple at Zemo Alvani, near the cemetery, is one of the tornado's travel points.

According to an eyewitness, farmer Kh. Chikhoshvili, it was possible to determine the approximate location of the tornado formation (Fig. 3; point 13 in Fig. 2 and Table 2).

Fig. 3. Approximate location of tornado origin. On the left is our photo, on the right is a still from the video of farmer Khvicha Chikhoshvili.

In particular, as follows from Fig. 2 and Table 2, distance from the approximate location of tornado formation to the center dome of the Cathedral is ≈ 5.7 km. The greatest distance we found from the site of tornado formation to point 3 is approximately 6.67 km. Thus, even without taking into account the tortuosity of the trajectory, the tornado covered a distance of at least 7 km. This fact, according to available data, is quite rare for the continental part of Georgia.

Table 2. Distance from approximate location of tornado formation to surveyed points according to Table 1.

N of points	0	1	2	3	4	5	6	7
Distance, km	5.67	6.45	6.54	6.67	6.36	6.03	5.86	5.67
N of points	8	9	10	11	12	14	15	16
Distance, km	5.45	5.97	5.71	5.71	0.41	1.32	1.00	0.67

Table 3 shows data on the distance from the central dome of the Cathedral to the points under study.

Table 3. Distance from the center dome of the Cathedral to surveyed points according to Table 1.

N of points	1	2	3	4	5	6	7	8	9	10	11
Distance, km	0.83	0.93	1.07	0.74	0.44	0.27	0.18	0.30	0.32	0.10	0.11

Along with the covering of the central dome of the cathedral, the tornado tore off the cross, which was found approximately 0.11 km from this dome on the territory of the cemetery (Fig. 2, Tables 1 and 3).

Other objects in the vicinity of the Cathedral were also damaged. So, for example, distance from the center dome of the Cathedral to agricultural cold storage farm (Point 1) is ≈ 0.83 km, and to farm with badly damaged roof (Point 9) is ≈ 0.32 km.

According to preliminary data, the tornado formed at approximately 5:10 p.m. and disintegrated at approximately 5:24 p.m.

In Fig. 4-8 for clarity, show photographs of some objects damaged by the tornado (farm roofs in the Zemo Alvani, covering of the dome of the Alaverdi Cathedral, badly damaged roof next to the cathedral, agricultural cold storage farm).

Fig. 4. Damaged farm roofs in the Zemo Alvani. (Point 15, Table 1).

Fig. 5. Removal of the covering of the dome of the Alaverdi Cathedral. The time interval between frames is 1 second. Video source: https://www.youtube.com/watch?v=ZFvYlzEhBr4.

Fig. 6. Damaged dome of Alaverdi Cathedral. Photo from drone.

Fig. 7. Farm with badly damaged roof next to the cathedral. (Point 9, Table 1).

Fig. 8. Agricultural cold storage farm. A part of the building's roof collapsed. Photo from drone. (Point 1, Table 1).

Fig. 9. Our group of scientists with His Eminence, Bishop of Alaverdi, Metropolitan David (in the center). From left to right - Nodar Varamashvili, Viktor Chikhladze, Avtandil Amiranashvili, Mikheil Pipia.

Finally, in Fig. 9 shows a photograph of His Eminence, Bishop of Alaverdi, Metropolitan David and the authors of this article against the background of the Alaverdi Cathedral with a damaged dome.

It is important to note that intensive work is currently underway to restore the damaged coverings of the cathedral and other parts of it.

Conclusion

In the near future, we plan more detailed studies of this natural phenomenon. In particular: determining the conditions for the formation of a tornado; determination of the trajectory and speed of movement of a tornado, taking into account radar data on thunderstorm and hail clouds in the study area; estimation of the speed of air flows inside a tornado; clarify the strength of the tornado, etc.

Acknowledgments

The authors thank everyone who assisted in carrying out the study: His Eminence, Bishop of Alaverdi, Metropolitan David; farmer - Chikhoshvili Khvicha; residents of the municipality; all persons and organizations that posted photos and video materials about the tornado in Kakheti on the Internet.

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კახეთში 2024 წლის 25 ივნისს ტორნადოს გავრცელების არეალის ექსპედიციური კვლევის ზოგიერთი შედეგი

ა. ამირანაშვილი, ვ. ჩიხლაძე, მ. ფიფია, ნ. ვარამაშვილი

რეზიუმე

წარმოდგენილია 2024 წლის 25 ივნისს კახეთში ტორნადოს გავრცელების არეალის ექსპედიციური კვლევის ზოგიერთი შედეგი. ალავერდის საკათედრო ტაძარში მეცნიერთა ჯგუფს შეხვედრა ჰქონდა მის მაღალყოვლადუსამღვდელესოებასთან აბბა ალავერდელ მიტროპოლიტ - დავითთან. დაწვრილებით იქნა განხილული ალავერდის ტაძრის დაზიანებები. მიღებული იქნა მნიშვნელოვანი ინფორმაცია ამ საკითხთან დაკავშირებით. შემდგომი კვლევა გაგრძელდა ტაძრის მიმდებარე ტერიტორიაზე და სოფლების ქვემო და ზემო ალვანის მიმართულებით. დადგენილი იქნა ქარბორბალას წარმოშობის სავარაუდო ადგილი, გავრცელების ტრაექტორია და არეალი. შესწავლილი იქნა გავრცელების ტრაექტორიაზე ქარბორბალათი გამოწვეული დაზიანებები. უახლოეს მომავალში იგეგმება ამ ბუნებრივი ფენომენის უფრო დეტალური შესწავლა.

საკვანძო სიტყვები: სტიქიური უბედურება, ქარიშხლი, ტორნადო, გავრცელების არეალი, ობიექტების დაზიანება.

Некоторые результаты экспедиционного исследования ареала распространения торнадо в Кахетии 25 июня 2024 года

А. Амиранашвили, В. Чихладзе, М. Пипиа, Н. Варамашвили

Резюме

Представлены некоторые результаты экспедиционного исследования района распространения смерча в Кахетии 25 июня 2024 года. Группа исследователей, посетившая Алавердский собор, встретилась с Высокопреосвященнейшим епископом Алавердским митрополитом Давидом. Подробно обсуждался ущерб, причиненный собору Алаверди и его окрестностям. По данному вопросу получена важная информация. Дальнейшие исследования были продолжены в районе Алавердского собора и в направлении сел Квемо и Земо Алвани. Определены вероятное место зарождения смерча, траектория и район его распространения. Изучен ущерб, причиняемый смерчем на траектории распространения. В ближайшее время планируются более детальные исследования этого природного явления.

Ключевые слова: стихийные бедствия, ураганные ветры, торнадо, ареал распространения, повреждение объектов.