

ANALYSIS OF STRONG PRECIPITATION IN TBILISI ON AUGUST 29, 2023

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Abstract: Precipitation of more than 100 mm per day falls very rarely in Tbilisi (several cases in the last 120 years). On August 29, 2023, this incident repeated itself. In this work an analysis of this rare phenomenon for Tbilisi is presented.

Key Words: atmospheric precipitation, flooding, flood.

Introduction

The study of the intensity and distribution of precipitation in Georgia has always been the most pressing problem among known atmospheric phenomena [1-5]. This has become even more relevant against the background of the ongoing process of climate warming [6]. Heavy precipitation leads to floods, landslides, mudflows, damage to vegetation, etc. [7-10]. Their deficiency contributes to droughts, desertification, decreased agricultural yields and other negative processes [6,7].

Floods due to heavy rainfall most often occur in western Georgia, although in its eastern part, including Tbilisi, these processes are not so rare [7-9]. For example, a heavy rainfall in the vicinity of Akhaldaba (a suburb of Tbilisi) led to a landslide, which subsequently provoked a catastrophic flood in Tbilisi on June 13-14, 2015 [10-12].

Floods due to heavy rainfall most often occur in western Georgia, although in its eastern part, including Tbilisi, these processes are not so rare [7-9]. For example, a heavy rainfall in the vicinity of Akhaldaba (a suburb of Tbilisi) led to a landslide, which subsequently provoked a catastrophic flood in Tbilisi on June 13-14, 2015, and were 20 people confirmed dead [10-12; https://en.wikipedia.org/wiki/2015_Tbilisi_flood].

Precipitation of more than 100 mm per day falls very rarely in Tbilisi (several cases in the last 120 years [5,12]). However, on August 29, 2023, this incident repeated itself. Below is an analysis of this rare phenomenon for Tbilisi.

Study area, material and methods

Study area – Tbilisi. The following information are used.

Data of Georgian National Environmental Agency, Hydrometeorology Laboratory of Tbilisi State University and satellite observation data [https://neo.gsfc.nasa.gov/view.php?datasetId=GPM_3IMERGM] about the daily sum of atmospheric precipitation

Data on vertical atmospheric sounding [<https://www.ready.noaa.gov/index.php>] for calculated of Indexes of Stability of the Atmosphere [http://weather.uky.edu/about_totl.htm].

Lightning data from [https://www.blitzortung.org/ru/live_lightning_maps.php?map=42].

In this work Total Totals Index (TT) and K Index stability of the atmosphere are used.

$$TT = T_{850} + T_{850} - 2 \cdot T_{500}; K = T_{850} - T_{500} + T_{850} - T_{700} + T_{700}, \text{ in degrees } C.$$

where T represents temperature and T_d represents dew point temperature at the indicated level (500, 700, and 850 mb).

Results and discussion

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

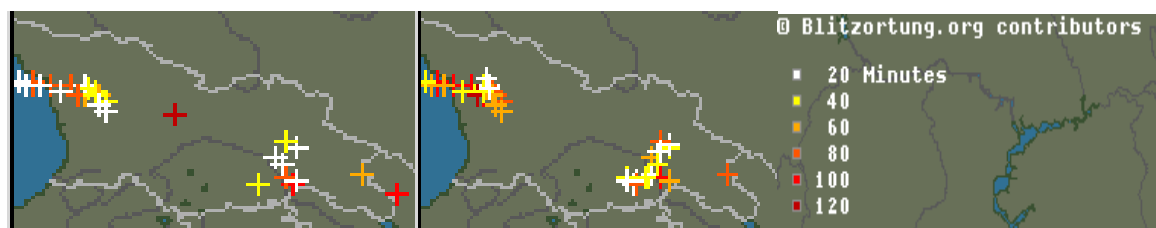
In Table 1 data about TT and K Indexes for Tbilisi from 04 hour, 29.08.2023 to 01 hour, 30.08.2023 are presented.

Table 1. TT and K Indexes for Tbilisi from 04 hour, 29.08.2023 to 01 hour, 30.08.2023.

Time/Date	TT	Qualitative Assessment	K	Qualitative Assessment
04.29.08.2023	48	Scattered Thunderstorms/Isolated Severe.	33	Numerous Thunderstorms. Heavy rain.
07.29.08.2023	48	Scattered Thunderstorms/Isolated Severe.	33	Numerous Thunderstorms. Heavy rain.
10.29.08.2023	50	Scattered Thunderstorms. Few Severe. Isolated Tornadoes.	35	Numerous Thunderstorms. Heavy rain.
13.29.08.2023	53	Numerous Thunderstorms. Scattered Tornadoes.	40	Very Unstable. Thunderstorms Very Likely. Very heavy rain.
16.29.08.2023	52	Scattered Numerous Thunderstorms. Few Scattered Severe. Isolated Tornadoes.	41	Extremely Unstable. 100% Chance of Thunderstorms. Very heavy rain.
19.29.08.2023	48	Scattered Thunderstorms/Isolated Severe.	37	Very Unstable. Thunderstorms Very Likely. Heavy rain.
22.29.08.2023	47	Scattered Thunderstorms/Isolated Severe.	37	Very Unstable. Thunderstorms Very Likely. Heavy rain.
01.30.08.2023	45	Scattered Thunderstorms.	35	Numerous Thunderstorms. Heavy rain.

As follows from Table 1, during the studied period of time, an unstable atmosphere was generally observed over Tbilisi. The TT index value varied from 45 (Scattered Thunderstorms.) to 53 (Numerous Thunderstorms. Scattered Tornadoes.), and the K index - from 33 (Numerous Thunderstorms. Heavy rain.) to 41 (Extremely Unstable. 100% Chance of Thunderstorms. Very heavy rain.). It should be noted that an unstable atmosphere was also observed over the territory of western Georgia.

Accordingly, during the indicated period of time, thunderstorms with heavy precipitation were observed over various parts of the territory of Georgia (including Tbilisi).



29.08.2023, 22.00 hour 29.08.2023, 22.30 hour Scale

Fig. 1. An example of the distribution of lightning discharges over the territory of Georgia on August 29, 2023 at 22.00 and 22.30 hours.

In Fig. 1 an example of the distribution of lightning discharges over the territory of Georgia (including Tbilisi) on August 29, 2023 at 22.00 and 22.30 hours.

On this day, precipitation was observed almost throughout the entire territory of Georgia.

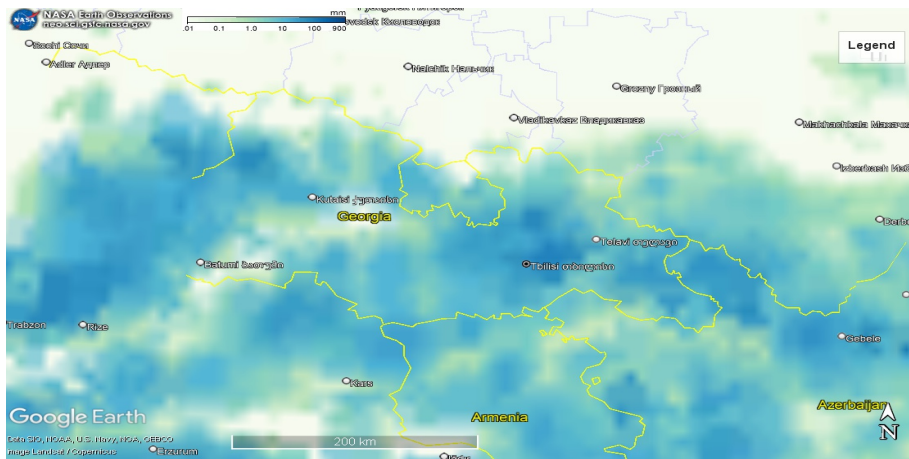


Fig. 2. Distribution of daily sum of atmospheric precipitations on the territory of Georgia at August 29, 2023.

In Fig. 2 satellite data about distribution of daily sum of atmospheric precipitations on the territory of Georgia at August 29, 2023 is presented.

According to the data of the Hydrometeorology Laboratory of TSU (H/S Svanidze), the amount of precipitation yesterday is equal to 104.4 mm; Hydrometeorology Observatory of National Environmental Agency - 113 mm; satellite data – 45 mm (averaging per 100 km²).

The rain started at approximately 20:00 Tbilisi time and lasted for three hours. As a result of the rain on August 29, 2023, streets, underground passages, cars, including public transport, were flooded, power lines were damaged, trees were knocked down, and landslide processes intensified in different parts of Tbilisi. Roofs leaked in some apartment buildings. In addition, water leaked into the Tbilisi International Airport building and metro tunnels (Fig. 3).

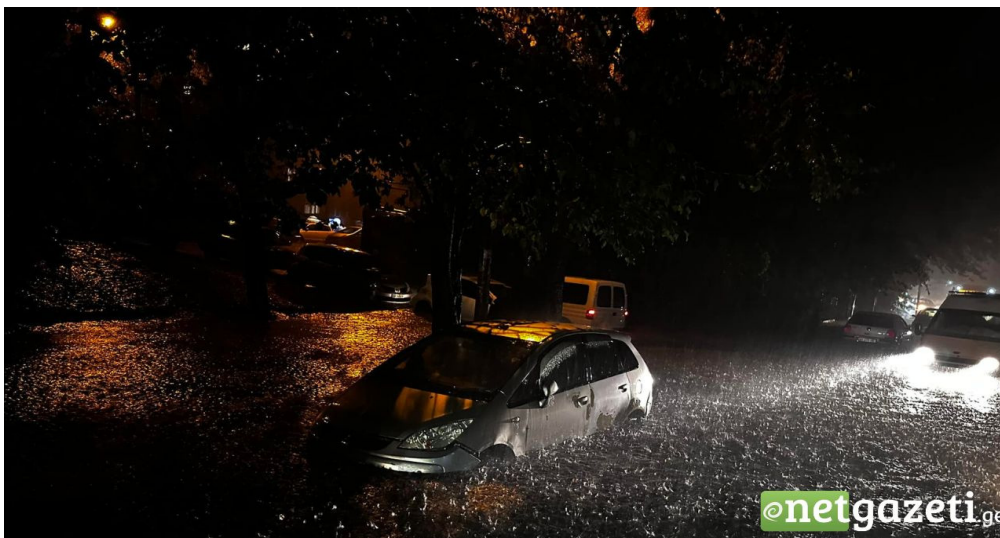


Fig. 3. An example of flooding of one of the streets of the city of Tbilisi during heavy rain on August 29, 2023
[\[https://netgazeti.ge/news/685793/\]](https://netgazeti.ge/news/685793/).

Note, that in Tbilisi according to meteorological stations precipitation of more than 100 mm per day from 1901 to 2020 only 5 times was observed [5,12]: May 11, 1940 (109.2 mm); June 17, 1948 (125.6 mm); August 16, 1955 (147.2 mm, max in the last 120 years); June 8, 1972 (130.1 mm); June 30, 1997 (117.7 mm).

On June 13, 2015 (Akhaldaba landslide), according to the weather station, the daily precipitation amounted to 49.3 mm. However, according to meteorological radar data, the amount of precipitation over the center of the top of the landslide from 21.00 to 22.33 hours exceeded 53 mm, and from 21.00 to 23.58 hours – 134 mm [12].

Conclusion

In the future, we plan to continue similar studies both for Tbilisi and other regions of Georgia, taking into account climate change.

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