Extreme climatic phenomena during the hot period of the year in Târgoviște Municipality and its surroundings (1961-2010). Case studies

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Abstract: Extreme climatic phenomena have an approximate forecasting character, and trigger serious consequences for the entire ecosystem. The consequences of some inevitable meteorological / climatic uncontrolled phenomena, possible under more or less known / prognosticated / anticipated conditions, can be: affecting the inhabitants from the floodable regions or the farmers because of the tough climatic conditions that often result in material and human losses.

Among the extreme climatic phenomena pertaining to the hot period of the year that occurred in Târgoviște Municipality and its surrounding area, in our study we have in view some more important ones, such as the heat waves associated with thermal maximums that generated tropical nights and also the precipitations with a torrential character accompanied by storm phenomena.

Key words: climatic extremes, Târgoviște, heat waves, torrential precipitations, storms.

1 Introduction

Târgoviște Municipality is situated on a high terrace (260 m), above the valley of Ialomița, at the boundary between the hilly Subcarpathian region and the High Plain of Târgoviște, which includes the interfluve situated in between Dâmbovița River and Ialomița Riverup to the boundary with the low and monotonous “divagation plain” which continues the subhilly plains (Fig. 1).

The pain is set apart from the uniformity of the Romanian Plain, as Târgoviște as it is situated in the subhilly sector of this plain, being part of the High Piedmont Plain of Ialomița, and situated in the vicinity of the Subcarpathian Hills.

The Meteorological Station of Târgoviște was created in 1940 and is situated at an altitude of 296.49 m, and according to the barometer of 297.19 m. Mathematically, it lays at 44°56’ northern latitude and 25°26’ eastern longitude, the local time being h + 18’. The station’s synoptic indicator is 15.375, and its climatologic indicator is 456.526.

2 Methods and means used in research

The climatic analysis of the phenomena and processes characterizing the spatial-temporal dynamics of the terrestrial atmosphere as well as the analysis of the relationships between them and the spatial support is permanently conditioned by the need to use quantitative data obtained via measurements. That is why these data lay at the basis of our analytical scientific approach.

The climatic data used to realize this study comes from the meteorological station of Târgoviște and the pluviometric posts of Valea Voievozilor, Șotânga and Nucet.

The series of basic meteorological observations
included, for Târgoviște station and for the pluviometric posts, the interval between 1961 and 2010.

Climatic data processing. The data processing, taking into account their evolution in time, relied on statistical-mathematical operations.

The analysis of the variations pursued the observation of the repeatability of the climatic parameters, with a higher or lower regularity, within the chronological series, in order to identify the fluctuations (average, deviations, period, frequency, probability, prevision, amplitude). These fluctuation parameters, which were analyzed as well in the present study, have characterized the climatic parameters and phenomena from the viewpoint of the level of development, of the dispersion and of the form.

The dispersion of the parameters and of the phenomena has been realized both for the extreme values and for average values. From among the statistic operations that laid at the basis of the representation of the dispersion, we used deviations and amplitudes. The parameters of the dispersion manage to define the climatic phenomenon from the viewpoint of its excessiveness.

In the case of the statistic analysis of the form of a phenomenon, the value series require a previous arrangement of the data on groups or on classes of values, which can be easily analyzed from an analytical viewpoint and can provide a synthetic image on the climatic phenomenon in itself.

The identification of the tendencies and of the cyclicities in the evolution of the climatic parameters has a great significance in the analysis of the climate variations or of the meteorological parameters in relation to a standard period of years. The tendency is defined as a slow variation, on the long run, of the parameter under analysis, which indicates the general direction of its evolution in time.

3 Special climatic phenomena during the hot period of the year

The climatic phenomena with negative consequences that occur during the hot period of the year have a common feature, namely the existence of high temperatures. They are due to the different degree of heating, either through direct solar radiation, or through hot tropical air, and constitute the main cause in the genesis, way of manifestation and territorial differentiation of the summer climatic risks.

The production of torrential rains and storms with hail, their intensity and their mechanic action exerted on the environment depends on the intensity of the thermal convection.

The incoming hot tropical air produced by continental advections determines heat waves, which are sometimes hot, and the latter, associated with the thermal convection, on the background of a mainly anticyclonic time, generate episodic droughts. At the same time, the incoming hot tropical maritime air during the hot period of the year, produced by oceanic or Mediterranean advections, can generate rich rains and an excess of humidity. In this sense, we can note the fact that there are cases of drought and dryness phenomena (the year 2000) and cases of humidity excess, possible throughout the year.

3.1 Heat waves

They are generated by tropical air advections and represent great non-periodical variations, which is why they can appear solitarily.

The positive thermal singularities are the expression of the heat waves, respectively of the hot continental air advections generated by continental anticyclones that develop in SE Europe, in SW Asia, in the Black Sea Basin, in the Balkan Peninsula and in the NW of the African continent.

In the context of the persistence of the anticyclonal baric formations, the local Sun-heating processes intensify, participating, along with the tropical air advections, to the increase of the heat and dryness degree, accentuating the value of the positive thermal singularities.

According to the average temperatures of the hottest months (July and August), the most intense heating phenomena are those equal or above 25° C; according to the absolute maximal temperatures, they are those over 30° C (tropical days), and according to the minimal nocturnal temperatures, they are those equal or higher than 20° C (tropical nights).

In this category, from the last seven year under analysis we can include the years 2000, 2005, 2006 and 2007, 2010, when cyclically, during July-August, there were periods of 5-12 consecutive days of daily temperatures of over 30° C at the meteorological station of Târgoviște.

As a representative case, we can mention the year 2007, characterized by a long and hot summer, determined by successive waves of tropical air brought by an anticyclonic front from North Africa. During that year, more than 100 summer days were recorded, of which 75 tropical and 20 hot, with a few tropical nights, from the month of May to the month of September.
If we consider the value of 35\textdegree C, six waves of hot weather were recorded: one in June (25-26), four in July (3-4, 17, 25, 28-30) and one between August 21-25. The least bearable period, in point of the thermal comfort was the interval July 14-30, the maximum temperature reached at Târgovişte approx. 38\textdegree C for 4 days (19, 22-24), exceeding 34\textdegree C for 14 days and seven nights, and a period not drop below the minimum temperature of 17-18\textdegree C. Between 16 to 30 July the same year, the average maximum daytime temperature was 37 to 37.50 C, 15 tropical days and 12 hot. Between July 17 to 25, there were four days with temperatures of about 38.5\textdegree C, but inside the city they have exceeded 44\textdegree C. We can also mention the year 2000, when, in conjunction with heat waves and small quantities of precipitation in the entire geographic area analyzed, there was a prolonged drought from May to late August.

3.2 Absolute maximum temperatures

Intrusion of warm air masses is designed to enhance local sunburn phenomena, leading to heat and dry atmosphere and soil.

Absolute maximum temperatures in the period examined did not exceed 400 C, and the highest values were in 2000, 39.10 C (July 5).

In winter season, the absolute maximum temperature recorded at between 16-20\textdegree C in January and February, in March about 25\textdegree C, and in April, nearly 28\textdegree C, in 1985. In the summer months, average temperatures oscillate around the absolute maximum values of 33-37\textdegree C, but may approach the value recorded in 2000. Autumn, the absolute maximum temperature varies around 28-30\textdegree C (Table 1).

Table 1. Absolute maximal temperatures at the meteorological station of Târgovişte, 1961-2010 (\textdegree C)

<table>
<thead>
<tr>
<th>Month</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
<th>IX</th>
<th>X</th>
<th>XI</th>
<th>XII</th>
<th>Yearly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values</td>
<td>17</td>
<td>20.3</td>
<td>25.7</td>
<td>26</td>
<td>33.9</td>
<td>34</td>
<td>39.1</td>
<td>34.4</td>
<td>31.9</td>
<td>31.0</td>
<td>24.2</td>
<td>20.8</td>
<td>39.1</td>
</tr>
</tbody>
</table>

Summer days are marked by the heat value greater than or equal to 250 C, and the possibility of their production is between 80-85 days per year. The highest frequency is recorded in July-August (25 days / month), when due to increasing solar radiation and invasion of air masses with continental tropical origin.

3.3 Hail storms, gales

Of all solid hydro-meteors, hail is a climatic risk which, although rare, may occur in a short time large-scale natural disasters, depending on which path Cumulonimbus cloud generated it.

In terms of average frequency of days with hail during the period of observation, they ranged between 1-4 and occurred in July and August.

Case study: the storm of 26-27 June 2007. The synoptic situation on the ground analysis shows that there was contact between a nucleus and a dorsal depression well organized than barrel Azores contact, that affected Romanian territory.

This core with tropical air remained a long time, which made the temperatures to be high, exceeding 30\textdegree C during the day and over 25\textdegree C at night.

Following this contact had been a declining trend in atmospheric pressure (Table 2).

Table 2. Atmospheric pressure evolution

<table>
<thead>
<tr>
<th>Hours</th>
<th>Time</th>
<th>Wind direction</th>
<th>Wind gust speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20:30</td>
<td>West</td>
<td>12 - threshold warning; lightning start</td>
<td></td>
</tr>
<tr>
<td>21:50</td>
<td>West</td>
<td>20 - aggravation threshold exceeded</td>
<td></td>
</tr>
<tr>
<td>22:00</td>
<td>West</td>
<td>37 - maximum</td>
<td></td>
</tr>
<tr>
<td>22:10</td>
<td>West</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rainfall has been accompanied by frequent lightning, between hours 21.50 and 23.02, and strong intensification of wind that reached the warning threshold exceeded and aggravation maximum wind gust was 37 m / s, about 133 km / h (Table 5).

Table 4. Quantities of precipitations fallen

<table>
<thead>
<tr>
<th>Pluviometric post</th>
<th>Dealu Alb</th>
<th>Râșca</th>
<th>Târgovişte</th>
<th>Găeşti</th>
<th>Lucieni</th>
<th>Valea Lungă</th>
<th>Butimannu</th>
<th>Titu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly</td>
<td>2.4</td>
<td>0.5</td>
<td>10.8</td>
<td>6.2</td>
<td>10.2</td>
<td>1.2</td>
<td>0.6</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Table 5. Evolution of the wind gusts
Although intensification of wind were of short duration, speed of production has led to some significant damage, especially in urban and rural areas of the Carpathian area and the latter's contact with the plains.

It was affected four towns (Fieni, Pucioasa, Târgovişte, Moreni) and 12 communes (Bezdead, Aninoasa, Bucşani, Dămâneşti, I.L. Caragiale, Vlădeni, Vâcăreşti, Râzvad, Doiceşti, Dragomireşti, Gura OcniŃei and Şotânga).

Material damage were measured in 63 affected residential blocks and 304 houses and rural households, 32 cars damaged and 182 felled trees that have blocked roadways and damaged road and rail network, affecting 1000 m of power network and approx. 200 m of phone network.

To the destruction of these consequences has been added socio-cultural objectives in rural areas, as it was, for example, cultural centers, schools, community schools and administrative offices.

### 3.4 Torrential rains

Uneven heating of the ground and dynamics very active of tropical wet air during the warm season in this period of the year are as often to get data torrential rain, the downpour becoming a climatic risk to the environment. In this category we can include heavy rains produced in 2001, 2005-2007, 2010 when, in breakthrough period, they exceeded the amount of rain fallen 80 l/m², which led to the generation of strong floods on the rivers that drain the county Dambovita.

The frequency of torrential rainfall intensity over a given area had an increased variability. Because they are isolated cases, the possibility that the can repeat in the same area is small, and often absolute value is reduced. Maximum average intensity is high, 4-5 mm / min., in the geographic area analyzed.

Studies on the effects of heavy rains and the results lead to the conclusion that the total, 70-85% are liquid, while the remaining 15-30% are accompanied by hail with a diameter of 10 mm, and the lightning. Only 1% of them can generate a 50 mm layer of water that can cause significant flooding. During rainfall, water flow is directly proportional to the loss of intensity and duration of precipitation and is dependent on genetic conditions.

Depending on the criterion Hellmann, they have a frequency between 1.2 to 8 cases per year. Average monthly maximum frequency ranges from April to September, with a larger number in July and August. Maximum number varies from 3-4 cases per year, indicating a relatively homogeneous distribution of torrential rains.

The average duration of heavy rainfall is around 200 min.; the maximum is 1290 minutes (Targoviste, 2-3 August 1997, when they totaled 128 mm of precipitation, with an average intensity of 0.10 mm / min.).

In what follows, we will refer to some relatively recent major events produced in the area studied.

Rainfall of 18-19 July 2002. An important phenomenon in the geographic area analyzed is the rain on 18-19 July 2002. Weather conditions that generated the intensity of precipitation have been caused by a slight increase in atmospheric pressure (735.4 mm of mercury) and an air temperature falling to 16.1ºC.

Rain began to fall at 23:30, taking 92 min of rain and thunder, with great intensity. This phenomenon was characterized by repetition. The first bursts of precipitation have occurred first at 1.09, with an intensity of 2.33 mm / min. for 4 min., with a losing water quantity of 9.3 mm. Immediately the rainfall intensity increased to 3.10 mm / min., for 3 min., with the same amount of water as before. At 1.32 the same intensity of precipitation was recorded, with duration of 3 min., when 75 mm of water had already fallen.

After 1.40 am, the intensity of rain fell at up to hour 14.09, when there was a slight increase in the intensity of 1 mm / min., and then to decline until the end (hour 6.00, on 19th July).

Heavy rains in June 22, 2004. On June 22, 2004, the central part of Europe was under the influence of an anticyclone. On the Romanian territory it has developed a broad valley, which has shifted from south to north on a depression corridor. The passage formed between the Black Sea and northern Scandinavia permitted entry of a warm Mediterranean air, but also a change that came into contact with a wet cold sub-polar air, which penetrated to our country. Contact zone between the two air masses allowed the development of convective instability exacerbated by heat, which led to the development of an activity that has generated high precipitation front, accompanied by thunderstorms and lightning phenomena.

It was a downpour, starting at 12.58, with a high intensity, between hours 12.58 and 13.22. After some pause, there was a second downpour, between

<table>
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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>22:20</td>
<td>West</td>
<td>23</td>
</tr>
<tr>
<td>22:30</td>
<td>West</td>
<td>13</td>
</tr>
<tr>
<td>22:40</td>
<td>North-West</td>
<td>9 - exit warning threshold</td>
</tr>
</tbody>
</table>
hours 16.14-16.40. Meanwhile, temperatures fell from 25.40 C (11.00) to 16.40 C (around 13.00) and atmospheric pressure has also fallen from 982.9 mb to 980.9 mb. The amount of water fallen totaled a layer of 6.7 mm.

Rainfall 7 to 8 May 2005. Genetic factors that have characterized the phenomenon of fluctuations were analyzed based on meteorological parameters such as:

- before the start of the precipitations, the atmospheric pressure decreased from 968.8 mb to 962.1 mb, until it finally reached between the hours 2:00 p.m. and 11:00 p.m. a value of 966.6 mb;
- at the appearance of this phenomenon, the air temperature was 11.8° C at 0:00 a.m., and then it increased by 0.4° at 6:00 a.m.; after this increase, the temperature decreased to 9.8° C at 6:00 p.m.

On the next day, the first rain downfall occurred between 1:20 a.m. and 1:40 a.m. The second downfall occurred between 2:10-4:15 a.m. Until 5:35 a.m., the rain had a maximal intensity; later on the phenomenon became less intense.

The total sums of precipitations fallen on the days under analysis ranged between 48.4 mm (Moreni) and 137 mm (Șotânga). Actually, the last value is the maximum recorded in the country during that month.

Briefly, the event was characterized by some features such as:
- the storm that occurred between 7:02 a.m. and 1:16 p.m.;
- the wind reaching a speed of 9 m/s having a direction north - north-east;
- the hail that occurred from 10:34 a.m. to 10:44 a.m., reaching a diameter of 6 mm.

4 Conclusions

The special climatic phenomena of the hot period of the year, under the period under analysis, included some more significant events such as:

- heat waves – we can highlight the years 2000, 2005, 2006 and 2007, 2010 when, during the months of July-August, in a cyclic manner, there have been periods of 5-12 consecutive days with daily temperatures over 30° C at the meteorological station of Târgoviște; as a representative case, we can mention the year 2007, characterized by a long and hot summer, determined by successive waves of tropical air brought by an anticyclonic front from north Africa; during that year, more than 100 summer days were recorded, of which 75 tropical and 20 hot, with a few tropical nights, from the month of May to the month of September;
- the absolute maximal temperatures did not go over 39.1° C on July 5;
- as far as the storms with hail and strong winds were concerned, we noticed a representative case occurring during the night of June 26/27, 2007;
- abundant precipitations were exemplified by the cases recorded in Târgoviște, on the days of August 2-3, 1997, July 18-19, 2002, June 22, 2004 and May 7-8, 2005.

Following these observations, we were able to notice that in Târgoviște Municipality and in its surrounding area, during the period under analysis, during certain years there were present some special climatic phenomena that could be included in the category of hazardous climatic changes, with consequences both on the environment and on the socio-economic activities carried out in the area under analysis. On the other hand, we have been able to highlight the fact that during the last ten years of the period, these phenomena had an ampler incidence, which implies new needs in the sense of their prevention.

Bibliography

Apostol L., Anomalii ale temperaturii aerului pe teritoriul României (Abnormalities of the air temperature on the Romanian territory), SCGGG, XXXVII, Editura Academiei Române, București, 1990, pp. 75-78.


Bîlțeau D., Dragotă Carmen, Intensitatea precipitațiilor extreme pe teritoriul României, (The intensity of extreme precipitations on the Romanian territory), Revista de Geografie (Geographic Review), nr. 6, serie nouă, 1999, pp. 12-14.


Dragotă Carmen Sofia, Precipitații excedentare din România (Precipitations over the average in


Măhăra Gh., *Variabilități și schimbări climatice* (Climatic variabilities and changes), Editura Universității din Oradea, 2006.


*** *Geografia României* (Geography of Romania), Vol. V, Câmpia Română, Dunărea, Podișul Dobrogei, litoralul românesc al Mării Negre și platforma continentală (The Romanian Plain, the Danube, the Plateau of Dobrogea, the Romanian Black Sea Coast and the continental platform), Editura Academiei Române, București, 2005.

*** *Clima României* (Climate of Romania), Editura Academiei Române, București, 2008.

***, Statistic data from the meteorological and hydrological stations of Târgoviște (1961-2010).