TORRENTIAL RAINFALL IN DOBRUDJA

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Key words: Dobrudja, torrential rains, climatic risk, Mediterranean Cyclone.

Abstract. Torrential rains fall during the warm season due to the intensification of the Azores Anticyclone activity, and the Atlantic and Mediterranean cyclone. Fundamental processes that lead to the development of cloud formations capable of producing large amounts of precipitation are, as it is known, convection and turbulent exchanges inside air masses. Summer rainfall in Dobrudja is of frontal nature and usually occurs during the day as showers. The correlation curve between the distance to the Black Sea of the pluviometric points and the maximum daily amounts of precipitation (24 hours) fallen during each of the summer months has a similar aspect to that of the average precipitation quantities on the Dobrudja territory during the warm period of the year (April-October) (Mihăilescu, 2001). Maximum amounts of rainfall (24 hours) decrease gradually from the land, from a distance of 30-35 km, with a tendency to reach the lowest values on the Black Sea littoral. The significant correlation coefficient between the distance to the sea and the maximum daily amounts of precipitation (24 hours) confirms their obvious influence on precipitation distribution in Dobrudja.

Introduction

The torrential rains fall in the warm period of the year as a result of the increasing activity of the Azore Anticyclone, as well as of the oceanic and Mediterranean one. They generate huge quantities of water that fall in a very short period of time, so they have very high intensity and cause great floods/freshets with severe consequences not only on human settlements and constructions, but also on the erosion processes which they accelerate on the more or less deforested slopes.

The fundamental processes that lead to the development of cloud formations capable of producing huge quantities of atmospheric precipitation are, as we all know, the convection and the turbulent exchanges inside the air masses.

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The summer time precipitations (also called rain showers) are of frontal nature in Dobrudja and they usually occur during the day time. The correlation curve between the distance to the Black Sea of the pluviometric points and the maximum daily amounts of precipitation (24 hours) fallen during each of the summer months has a similar aspect to that of the average precipitation quantities on the Dobrudja territory during the warm period of the year (April-October) (Mihăilescu, 2001). The maximum quantities of precipitation (24 hours) decrease gradually from a distance of 30-35 Km inland, with the tendency of reaching the lowest amount on the Black Sea littoral. The main correlation coefficient between the distance to the sea and the maximum daily amounts of precipitation (24 hours) confirms their obvious influence on the precipitation distribution in Dobrudja.

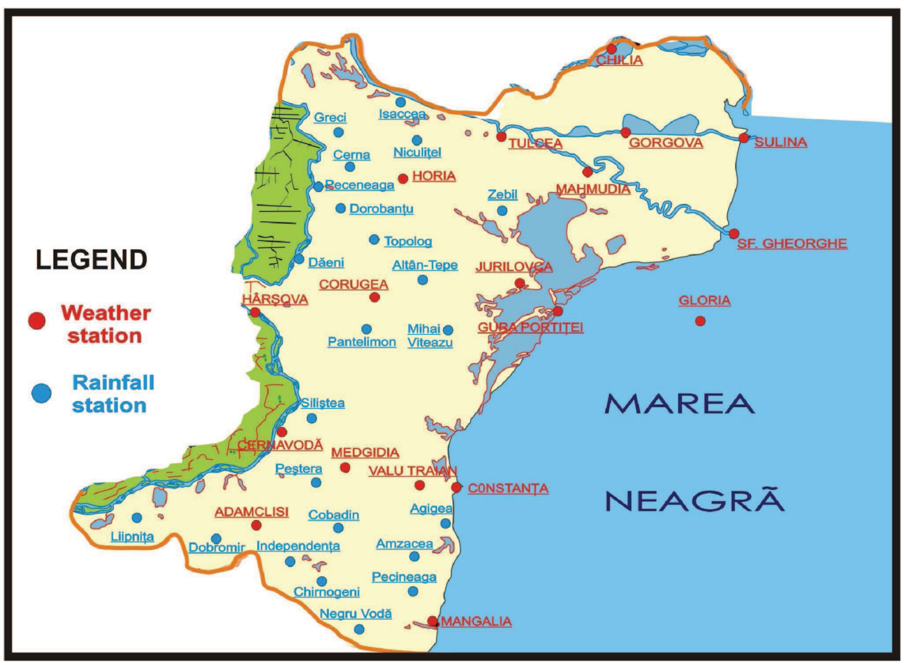

Fig. 1 - Utilised weather stations and rainfall stations in Dobrudja

During the warm period of the year and especially during the summer months, the longitudinal position of the isohyets, according to the orientation of the seacoast and the rapid growth of their inland value, cover a larger area in South Dobrogea, where the terrain is more fragmented compared to North Dobrudja. In South Dobrudja, the sea breeze front which penetrates the interior of the inland is slightly altered by the steppic plateau, due to the low altitude and its relatively reduced fragmentation.

One characteristic feature of the territorial distribution of the maximum daily rainfall (24 hours) is that the highest quantities are recorded at a distance of 30 to 35 Km from the Black Sea shore, namely where the inland value of the isohyet disappears or decreases due to the diminished influence of the sea breezes.

For the elaboration of this study we used the rainfall data recorded between 1965-2005 from 18 meteorological stations and 23 rainfall stations, figure 1.

1. Definition and genetic cases

The unequal terrestrial warming and the extremely active tropical air dynamics of the warm period of the year in the South-East of Romania determines torrential type of rainfall (showers) characterized by great and intense quantities of water in a very short period of time. These showers have negative consequences causing floods/freshets, erosion and washing of the soil etc. Generally, the precipitations which exceed a quantity of 25 mm in 24 hours are considered torrential (Platagea, 1959, Pătachie 1973). These usually occur under certain circumstances:

-the contact between two maritime air masses as a cold or occlusive front, of which one should have tropical origins;

-the intensification of the cyclonical activity and of cyclonic families;

-the conservation of the saturated air even after cloud formation (through adiabatic relaxation and mixing of the air masses)

-the values of the specific humidity should exceed 7g/Kg, and the humidity deficit should be maintained low in the active layer of cloud formation;

-the thickness of the already formed clouds should be over 7500m, and their base should be situated at 1000-1500m above the ground (the vertical clouds contain drops of 5mm in diameter and fall at a speed of 8m/s, while the stratiform clouds have diameters of tens of millimeters and fall at a speed of 30cm/s.

The other conditions for cloud and precipitation formation (the existence of a large number of condensation nuclei, the existence of lower altitude temperatures (below -15 C^0 at 5000m), isohypses with cyclonical curvature, development of electrical charges inside the cloud masses etc. are characteristic to all types of rainfall (Topor, 1970).

For Dobrudja we can separate the following synoptic conditions that were favorable between 1965-2005:

a. The propagation of the Azore anticyclone above central Europe separated by the eastern continent anticyclone through the thalweg line (the lowest point) that unites the lowest area of the polar seas with the one from South-East Europe. This synoptic situation caused abundant precipitations (40-60 mm) in Dobrudja between

June 30-31. This situation occurred because of the link between the two above mentioned anticyclones (Azore and the one from south east Europe), which lead to the formation of a maximum pressure regime that separated the depression from polar seas from the one from the south and south–east of Europe, marked by an intensification of a frontal activity.

b. The extension of the Icelandic Minimum all the way to the south of the continent, because of the extremely low depth (945 mb in its centre). The Icelandic Minimum penetrated deeply inland, connected with the African depression and generated a meridional circulation of air that, through the cold fronts, caused very abundant precipitations in the region of Dobrudja reaching 50mm between February 10-11, 2003.

c. The opposite North-Eastern Romanian (retrograde) depression, formed in the depression corridor between the Azore anticyclone and the one from North-Eastern Europe. The retrograde (opposite) character of the depression travelling south-west and north-east was determined by the dam represented by the Eastern Europe anticyclone which deviated it to the west.

d. The oceanic cyclone which travels across Romania from west to east, especially in winter when it occurs in the thalweg of the vast Atlantic depression zone and determines abundant precipitations as a result of the intensification of the dynamic convection. The cyclonic activity is very intense during spring time as well. A good example could be the May 1970 situation when the cyclonic whirlpools were made up of three masses of air: one moderately cold and located in the frontal part of the cyclonic area, another warm one located in the south and centre of the depression and a third one in the north-west side of the cyclone, extremely cold, of polar origin. The three masses of air were separated by atmospheric fronts along which formed the clouds that gave the abundant precipitations.

e. The weak anticyclonic field that covers the Atlantic Ocean up to the Caspian Sea and separates the vast Icelandic depression from the smaller one from the south-west of Europe. The high altitude penetration of the warm and unstable air masses into the anticyclone, specific to the depression minimums, and strong insolation at ground level led to the very intense thermo-convective movements, along with the dynamic convection movements specific for high altitude landscape, facilitating thus the formation of the Cumulonimbus clouds.

f. The formation of the Mediterranean cyclones causes torrential rainfalls in Dobrogea during the winter and spring months.

g. The depression corridor formed between the Icelandic depression and the depression area in the eastern basin of the Mediterranean Sea favors (makes it possible) the occurrence of precipitations in abundant quantities. Thus, at the contact between the humid, cold, polar air and the dry, warm, tropical one, a very unstable area forms, especially when the cold humid polar air suddenly replaces the warm one at high altitude.

h. The activation of the polar front above our country. Because of this reason, the quantities of rainfall registered in Dobrudja in May 1970 were three-four times above the average level. The activation of the polar front above Romania was triggered by the incredibly harsh winter above Northern Europe where the spring was not felt until the end of May. The air masses that penetrated the Romanian territory were pure and unaltered. If the position of the polar front had been north of Romania, the weather here would have been dry and warm. On the contrary, if it had been south of Romania the weather would have been cold and humid.

2. The torrential rainfall parameters in Dobrudja

The torrential rainfall parameters such as intensity, duration, quantity vary with the territory and are dependent on altitude, landform (relief), distance to the sea, as well as other local and weather conditions.

2.1.The average intensity of the torrential rainfall. The intensity of the torrential rainfall represents their main characteristic. Thus, by calculating and processing the data recorded over a 41 year period (1965-2005) we conclude that the most intense rain showers occurred as a result of the above mentioned conditions, in the western part of Dobrudja, near Valu lui Traian area (over 10mm/minute), while the least intense (in intensity) rain showers (under 6mm/minute) occurred in the southern area, as well as the littoral area of the Dobrudja Plateau, (figure 2, table1).

Tab. 1 - Maximum intensity of precipitations in Dobrudja (1965-2005)

Weather stations	Maximum intensity (l)	Duration (minute)	Date
Adamclisi	**5.90**	1	July 1, 1981
Constanţa	**8.0**	1	August 28, 2004
Corugea	**9.30**	1	September 5, 1989
Hârşova	**10.00**	1	July 11, 1967
Jurilovca	**5.10**	1	July 11, 1977
Mangalia	**7.40**	1	August 28, 2004
Medgidia	**7,0**	1	August 28, 2004
Tulcea	**7.40**	1	July 16, 1982
Valu lui Traian	**10.20**	1	July 13, 1978

2.2. The frequency of torrential rainfall. The torrential rainfalls do not occur regularly throughout the year or from one month to the other.

There is a great non-periodical instability of the torrential rainfalls, mainly because of their link to the characteristics of the general air circulation above the Romanian territory, to the characteristics of the active surface, and of the climatic influences.

Therefore, in Dobrudja, the frequency of years with no torrential rain showers increases gradually from west to east. On the littoral area, under the influence of Black Sea, this frequency is at its highest as 85% of the cases are caused by the higher degree of humidity induced by the marine aquatorium.

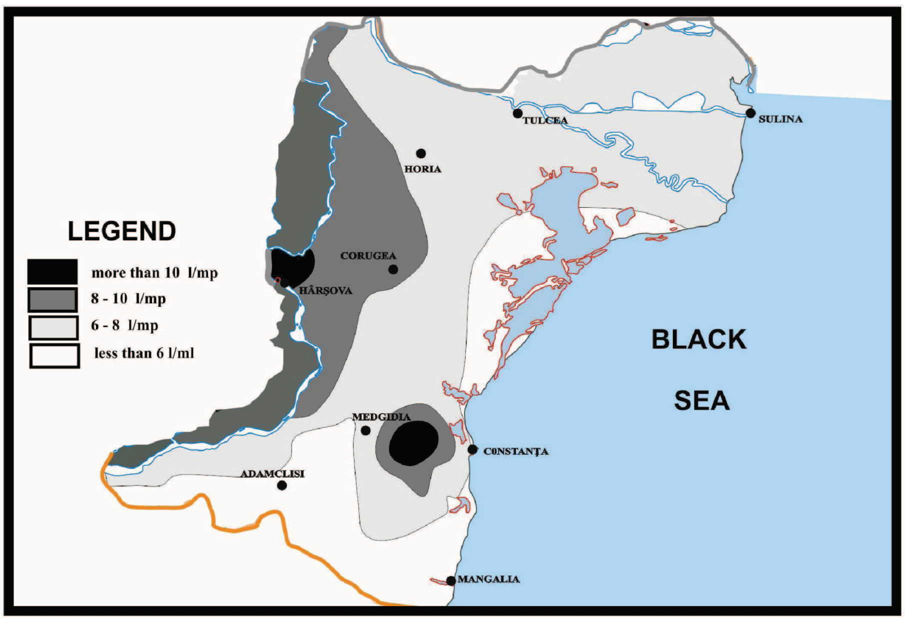

Fig. 2 - The maximum intensity of precipitations in Dobrudja (1965-2005)

The analysis of the torrential rainfalls between 1965-2005 (divided in two sub-periods) clarified some facts regarding the increase of the torrential rainfall frequency between 1991-2005 versus the 1965-2005 period (table 2).

1. During the second sub-period (1991-2005) the annual frequency of the abundant torrential rainfalls meant 10.4 cases compare to 8.5 cases during the first sub-period (1966-1990)

2. The distribution character in time has changed. During the first sub-period the maximum number of torrential rainfall occurred in June (38.5%).

During the second period, however, the number has greatly decreased (16.6%). On the other hand, the number of the abundant torrential rainfall for July increased from 22.4% to 37.2%. The same trend was noticed for the month of August.

3. Those changes could be the effects of the climate changes at regional level.

2.3. The duration of the torrential rainfall. Generally, there has been noticed an inverse report between the intensity and the duration of the rain shower: the greater the intensity, the smaller its duration and vice versa.

This way, the frontal torrential rainfalls have the highest duration (over 4 hours), but their intensity decreases suddenly under 0.20 mm/min and even lower. The higher the intensity, the smaller the duration so that the rainfalls with intensity under 1mm/min have a duration of 60 minutes, while the ones between 1 and 2 mm/min last approximately 30 minutes and so on.

For the Dobrudja territory between 1965 and 2005, there was a smaller duration in the western part, near Valul lui Traian area, and a greater duration in the littoral and meridional areas.

Tab. 2 - The frequency of the abundant torrential rainfall in Dobrudja over the 1965-2005 period

Period	April	May	June	July	August	September	October	Total	Annual
1965-1990 (24)	1 case 0.5%	23 11.2	79 38.5	46 22.4	35 17.1	18 8.8	3 1.5	205 100	8.5
1991-2005 (14)	-	11 7.6	24 16.6	54 37.2	35 24.1	18 12.4	3 2.1	145 100	10.4

2.4.The water quantity. During the torrential rainfall, the resulted quantity of water is directly proportional with the intensity and duration of the rain. The quantity of water also depends on genetic conditions.

The highest amount of water falls during the rain showers with frontal origin, when the thermo-baric contrast is very big. The highest amounts of water were noticed in August in Constanta, Valul lui Traian, Agigea and in September in Mangalia, while in the central and high areas in the north-west, the most considerable water amounts were recorded in July (at Corugea for example), table 3.

A characteristic of the territorial distribution of the maximum daily precipitations (24 hours) is that during the summer months, the highest quantities occur at a distance of 30-35 Km from the Black Sea. That is the distance where the inland isohyet values decrease or vanish completely because of the reduced influence of the marine breezes. When the precipitations are reduced or do not exist at 30 Km distance from the Black Sea, there are some specific, synoptic situations that occur every summer month with maximum daily precipitations (in 24 hours) close to absolute values. Let's take, for example, June 22, 1987.

Tab. 3 - The maximum amount of rainfall (mm) in 24 hours in Dobrudja (1965-2005)

Weather station/ Rainfall station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Constanța	46.7	28.3	44.7	50.1	49.8	69.9	44.4	205.5	58.4	75.7	56.8	28.0
Mangalia	33.6	29.4	31.4	62.8	66.7	69.1	59.4	86.6	127.7	50.1	68.6	31.6
Hârşova	77.1	33.0	27.2	35.8	58.4	64.1	83.4	87.6	96.7	46.5	38.3	37.7
Medgidia	25.2	29.5	27.3	45.7	48.0	52.0	61.2	84.5	67.6	38.9	34.8	35.0
Adamclisi	25.4	23.0	34.2	58.9	65.4	67.4	45.0	60.3	83.3	52.8	39.4	44.5
Valu lui Traian	29.4	26.8	50.2	51.2	51.1	80.4	99.6	151.5	78.8	46.0	46.2	33.9
Cernavodă	56.6	28.8	33.6	52.3	47.6	69.4	58.3	82.4	61.4	48.2	29.9	54.7
Agigea	43.7	41.0	32.7	59.5	43.5	78.1	112.0	280.5	87.0	50.4	36.3	36.7
Năvodari	34.7	30.8	18.9	42.2	37.2	41.5	70.0	77.0	44.0	61.5	32.8	26.3
Tătaru	48.8	28.0	56.0	55.1	87.5	90.0	49.0	75.3	70.0	83.0	35.1	67.6
Basarabi	44.5	25.4	46.1	53.0	62.7	100.3	57.0	53.2	62.8	37.1	50.0	27.3
Amzacea	54.9	23.0	49.4	42.4	102.0	68.0	61.7	82.6	101.5	47.0	33.5	26.0
Bărăganu	29.3	20.3	46.0	37.4	68.2	56.5	48.4	76.1	85.5	45.0	45.7	37.2
Nisipari	25.5	32.2	28.1	34.6	37.8	70.0	55.0	86.9	93.8	43.0	34.4	50.2
Nicolae Bălcescu	41.7	36.5	27.6	38.9	46.2	129.0	61.0	60.5	55.9	63.1	30.2	26.4
Negru Vodă	43.7	30.8	43.1	52.0	57.3	155.8	66.0	65.0	69.5	60.5	37.5	51.0
Cobadin	43.0	34.1	35.0	58.0	62.6	94.0	95.0	61.0	75.8	37.1	43.9	35.0
Alimanu	31.2	27.3	54.0	46.0	70.1	69.9	56.0	89.0	47.1	41.0	41.0	48.8
Lipnița	45.7	36.4	54.7	38.2	63.9	80.0	49.0	63.1	134.8	49.7	38.4	31.3
Ostrov	48.0	49.0	35.5	28.2	43.0	84.5	45.3	83.0	83.8	60.4	40.6	51.0
Tulcea	45.2	27.8	43.1	49.9	48.8	68.7	79.3	78.8	57.2	74.7	55.4	26.7
Jurilovca	32.6	27.8	30.4	61.7	65.7	67.1	80.2	78.9	55.4	73.3	56.9	28.1
Chilia Veche	46.1	28.8	44.6	51.5	59.9	70.2	79.9	83.7	66.5	69.8	57.0	29.7
Sf. Gheorghe	46.9	28.5	43.7	50.8	47.8	67.9	47.4	134.5	100.9	88.9	65.5	31.1
Corugea	44.5	25.4	46.1	53.0	62.7	77.7	81.5	78.7	54.1	53.2	43.7	25.2

The absolute values of the maximum daily precipitation quantities were registered at Scarisoreanu (168.0 mm) and Negru Voda, which is 18Km further south (155.8 mm). Both towns are located at approximately 30 Km from the Black Sea, at the western limit of breeze influences.

3. Risk factors

The torrential rain falls have a risk factor if they trigger accelerated erosion processes on slopes, or generate flooding etc. The destructive effect of the torrential rain falls depends on intensity, duration, water quantity, wind speed, characteristics of the active surface such as: slope size, tenderness of the lithological layer underneath, forestation degree, time of the year etc. For example, if this comes after a long period of drought when the soil is very dry and the particles cohesion is reduced, the erosion power of the rain is extremely high. If we refer to the 1965-2005 period only, from the total destroyed area of 28,066 ha in Constanta county, a surface of 12,353ha (44%) was destroyed by torrential rain, 11,502 ha (40,8 %) were destroyed by hoarfrost/frost/thaw and 3.128 ha (11.1%) by high winds, the rest of the surface being affected by other risk climatic phenomena, (table 4). The torrential rain was responsible for losses of 16 million RON, which represents approximately 4.5 million, that is approximately 1295 RON/ha of affected crop (Department for Agriculture and Rural Development (DARD) Constanta).

A tremendous amount of damage was recorded as being caused by torrential rain in the past years, especially during the analyzed 41 year period. The most relevant situations are:

The torrential rainfall from August 28, 2004. Exceptionally intense rain fall activities were recorded in Constanta county (on the Black Sea littoral) on August 28, 2004, between 5.50 a.m. and 9.10 p.m. In the area between Agigea, Techirghiol, Valu lui Traian, Lumina, Mamaia Sat and Constanta the recorded quantity of precipitations exceeded 150mm/mp. Thirty six streets and boulevards, 110 houses and 20 commercial buildings were flooded. The cultural touristic objectives were not excepted. The water torrents invaded the Summer theatre in Mamaia, the Roman Mosaic Museum, The Faleza harbor, Constanta station and other places.

The city sewage system could not face the calamity, and the water level reached almost 1 meter on some streets.

In Agigea, 11 houses were flooded (6 of them had the basic structure completely affected). The quantity of precipitations reached 280.5 l/mp in Agigea. 14 houses were greatly damaged in Lazu, while in Navodari, 98 houses were affected, 4 of which were demolished, tens of basements were flooded, a portion of 3Km of road was deteriorated and the electrical stations caught fire because of the

Tab. 4 - The size and structure of the surfaces destroyed in Constanta county by the main climatic risks between 1965-2005

Location	The average size of the affected area	Of which:							
		Torrential rainfall and hail		High winds		Hoarfrost/Frost/Thaw		Other factors	
		Ha.	% of the affected area	Ha.	% of the affected area	Ha.	% of the affected area	Ha.	% of the affected area
Agigea	150	**50**	**33.4**	-	-	100	66.6	-	-
Albeşti	620	**241**	**38.2**	252	40.1	136	21.6	-	-
Amzacea	1048	**737**	**70.3**	-	-	395	29.1	6	0,6
Ciocîrlia	630	**99**	**15.7**	271	43	260	41.3	-	-
Cobadin	192	**144**	**51.6**	-	-	135	48.4	-	-
Mangalia	279	**144**	**51.6**	-	-	135	48.4	-	-
M.Kogălniceanu	1694	**1098**	**64.8**	89	5.1	507	30.1	-	-
Nazarcea	393	**2**	**0.5**	82	20.9	309	76.6	-	-
Negru Vodă	1741	**992**	**57**	561	32.2	188	10.8	-	-
Topraisar	222	**-**	**-**	-	-	222	100	-	-
Cogealac	1921	**1509**	**78.5**	-	-	599	20.9	13	0.7
Dorobanțu	1204	**802**	**66.6**	300	24.9	102	8.5	-	-
Murfatlar	695	**8**	**1.2**	-	-	687	98.8	-	-
N. Bălcescu	1164	**772**	**66.3**	44	3.8	348	29.9	-	-
Poarta Alba	591	**331**	**56**	30	5.1	150	25.4	80	13.5
Săcele	832	**334**	**40.1**	172	20.7	326	39.2	-	-
Târguşor	1912	**1003**	**52.5**	15	0.8	697	36.4	197	10.3
Tortomanu	964	**245**	**25.4**	-	-	427	44.3	292	30.3
Medgidia	1391	**247**	**17.8**	-	-	1144	82.2	-	-
Independența	176	**-**	**-**	176	100	-	-	-	-
Peştera	868	**40**	**4.6**	300	34	435	50.1	93	10.7
Pietreni	2227	**1323**	**59.4**	-	-	573	25.7	331	14.9
Stupina	764	**102**	**13.4**	-	-	662	86.6	-	-
Vulture	619	**-**	**-**	619	100	-	-	-	-
Crucea	804	**-**	**-**	-	-	804	100	-	-
Hârşova	463	**463**	**100**	-	-	-	-	-	-
Adamclisi	209	**-**	**-**	209	100	-	-	-	-
Băneasa	673	**482**	**71.6**	-	-	191	28.4	-	-
Cernavodă	1278	**144**	**11.3**	-	-	1021	79.8	11.3	0.8
Ostrov	2324	**1185**	**51**	8	0.3	1124	48.4	7	0.3
Total County	28066	**12353**	**44**	3128	11.1	11452	40.8	1133	4.1

lightning phenomena. 20 houses were flooded in Techirghiol. The balneary sanatorium/spa was considerably damaged. In Eforie Nord, the cliff from the Belona area was affected on a 2 Km portion.

The quantities of precipitation recorded during a 15 hour period were extremely high. There were 280.5 mm/mp in Agigea, 205.5 mm/mp in Constanta, 200.0 mm/mp in Mamaia Sat, 169.0 mm/mp in Techirghiol, 151.5 mm/mp in Valu lui Traian, 147.7 mm/mp in Lumina, 120.0 mm/mp in Mircea Voda, 105.0 mm/mp in Crucea (50.0 mm/mp between the hours of 4.02 p.m. and 4.10 p.m.), 82.6 mm/mp in Amzacea (68.0 mm/mp in one hour) etc.

From all the observations made during the entire functioning period of the meteorological power plants, we concluded that the quantity of precipitation in a 24 hour period was much smaller than the quantities recorded during the torrential rain showers of August 28, 2004.

Thus, the maximum quantity fallen in a 24 hour period in August exceeded 150 mm. However, the rainiest month of August in all years turned out to be in: 1939 when 167.3mm/mp were recorded, 1947 with 150.8 mm/mp and 1972 with 137.5 mm/mp in Constanta (for the 1885-2004 interval), in Medgidia 135.4 mm/mp, in Harsova 144.1mm/mp, Navodari 77.0mm/mp in 1984, in Amzacea 78.0 mm/mp in 1999, in Mangalia 86.6 mm/mp in 1984, in Agigea 84.3 mm/mp in 2000, in Valu lui Traian 87.4 mm/mp in 1964, during a 50 year and plus interval.

We will present below, the events of 28th August 28, 2004 (figure 3).

We can see on the synoptic map above Romania that there is a thalweg (the lowest point) linked to the Icelandic depression which occupies (stretches) the north and north-west of Europe. Those are associated with a series of atmospheric fronts starting from the Scandinavian Peninsula all the way to the eastern part of the Mediterranean Sea. We can also observe a tendency of cyclogenesis in the Black Sea area, which represents two closed isobars. It separates the cold air masses of the depression from the north-west of the continent which permits it to gain from the point of view of time persistency.

This implies a whirlpool type of movement of the cyclonic field and marks an important decrease in the middle troposphere temperature.

As a consequence to the dynamic ascending movements which develop into the actual cyclonic field, a thermal component is added. It express the atmospheric instability caused by the rapid decrease of air temperature with the altitude and determines precipitations of great intensity as you can see in table 5.

The recorded quantity of precipitation could be divided into four classes: small (19-40 l/mp), middle (41-85 l/mp), big (86-170 l/mp) and very big (171-281 l/mp). It is important not to forget that the precipitations have a huge discontinuity in space and time. For example: the development of a Cumulonimbus type of cloud from which 40-60 l/mp of rain can fall in one area, and no rain whatsoever in another area. There could be frontal situations of development of strong cloud systems on a portion of 3-4 Km. A quantity of 100-150 l/mp could fall while the height of the Cumulonimbus clouds could reach 10000-14000m.

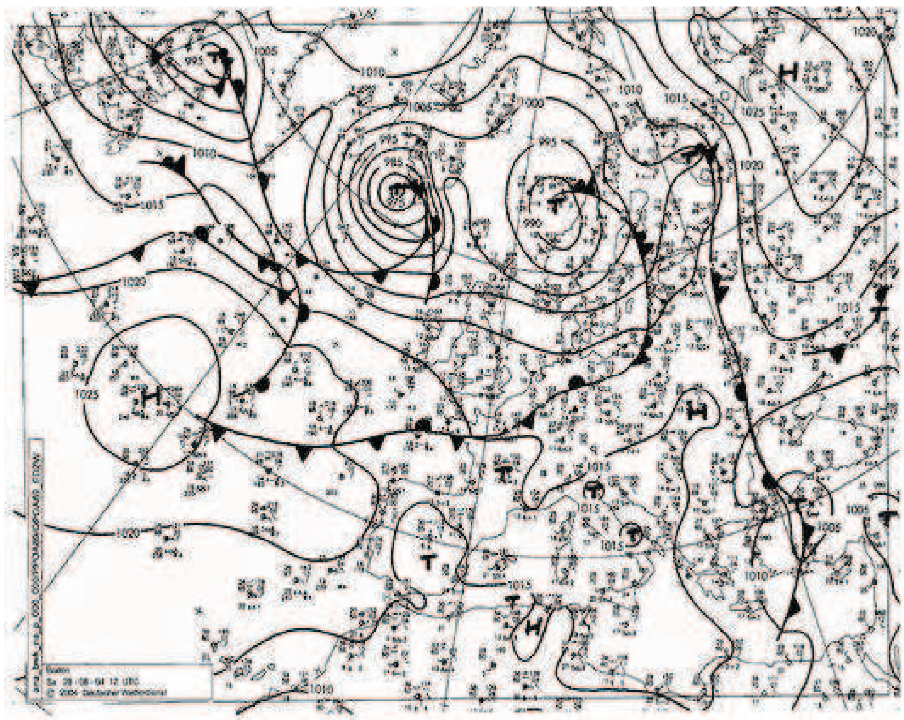

Fig. 3 - The synoptic map of Europe on August 28, 2004, at 12:00, at the ground level

Those can lead to the conservation of the atmospheric masses with intense ascending movements in the middle of the cyclone, with a strong instability, high humidity, Cumulonimbus type of clouds, systems of cells and super cells which continuously develop and disappear.

The resulting phenomena: intense rain showers, strong wind gusts, lightning, a considerably high quantity of precipitations, they all determined a strong dislocation of air leading to thunderstorm and even marine tornado in Mamaia resort, which caused a lot of damage.

The exceptional quantities of precipitations fallen in Dobrogea on August 28, 2004 represent a unique case in the history of this region. The causes are: the synoptic and dynamic nature of the situation, linked to the configuration of the baric field as well as the thermal nature, which determined the development of Cumulonimbus type of clouds.

The effects of this special rain of catastrophic nature led to the flooding of houses, basements, roads, agricultural crops, as well as material losses, deviated railways and motorways, interrupted harbor activities etc.

On July 3, 2005, as a result of the torrential rain fallen in the Topolog basin (121 l/mp, from which 113 l/mp during the 6:00 to 9:00 interval) an overflowing of the Topolog river occurred. This affected the protection dam of the Saraiu village. On that day, the following readings were recorded at the Saraiu hydrometrical station: 752 cm, with 202 cm above the danger point.

During the interval of September 22, 2005, 8:00 and September 23, 2005, 8:00, important quantities of torrential type precipitations were recorded on the Constanta county territory. They exceeded the critical limit/point of precipitations and caused floods. The recorded quantities during the above mentioned interval exceeded the critical points/limits of most pluviometrical stations of the area. The highest numbers were recorded at: Eforie, 161.5 l/mp; Biruinta, 222.0 l/mp; Techirghiol, 200.7 l/mp.

Tab. 5 - The amount of rain (l / m) fallen on August 28, 2004

Weather station/Rainfall station	**The amount of rainfall (l/mp)**	**Weather station/ Rainfall station**	**The amount of rainfall (l/mp)**
Cogealac	19.3	Harsova	76.6
Mangalia	21.9	Biruinta	77.4
Almalău	27.8	Cernavoda	77.2
Ostrov	30.0	Amzacea	82.6
Oltina	35.0	Saraiu	84.4
Negureni	37.2	Crucea	105.0
MihaiViteazu	37.8	Cobadin	106.0
Corugea	40.0	Mircea Voda	120.0
Silistea	57.0	Lumina	147.7
Negru-Voda	59.2	Valu lui Traian	151.5
Adamclisi	59.8	Techirghiol	169.0
Independenta	60.2	Mamaia Sat	200.0
Medgidia	60.6	Constanta	205.5
Pestera	64.0	Agigea	280.5
		Pantelimon	312.0

On September 22, 20025, around the Costineşti area, highly disastrous rainfalls swiped out the area. Basically, the non-permanent valleys of Costineşti and Schitu swelled up and spread towards the towns of Costineşti and Schitu, where the altitude is lower. The 2.5 meter railway track blocked the waters from flowing towards Costinesti lake and the sea. Part of the town was flooded and when the railway track gave way under pressure, the water debit swiped everything in its path, destroying houses, drowning people and cattle, ruining the pedestrian alley and approximately 4 ha of beach, flowing eventually into the sea.

Conclusions

The torrential rainfall constitutes the object of complex and various research because of their specifications (gravity, reoccurrence, spatial effects, temporality etc.). They are in the centre of attention of international organizations (F.A.O. etc) and specialized institutions from various countries, through their economic and ecological impact.

The Dobrudja region stands out through its specific meteorological conditions, defined by the physical and geographical characteristics of the territory. Firstly, the two major components of the active surface: sea and land, mixed with the atmospheric circulation processes determine a relatively high frequency of the rain showers. The necessity to know these less studied phenomena is imposed by ecological discrepancies and negative economic effects on a given territory, whether it is agricultural (intensively practiced on great areas), touristic or intended for helio-marine therapy, naval, railway, electrical and telecommunication etc.

The knowledge of the torrential rainfall's distribution and regime imposes a detailed, comparative evaluation that could be achieved spatially and temporally through complex economic, ecological, and climatic indicators.

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Bibliography:

Apostol, Liviu (2004), *Clima Subcarpailor Moldovei,* Editura Universităii din Suceava,. Suceava, pag. 424

Bogdan, Octavia (1978), *Fenemone climatice de iarnă şi de vară*, Editura Ştiinţifică şi Enciclopedică, Bucureşti.

Bogdan, Octavia, Niculescu, Elena (1999), *Riscurile climatice din România*, Academia Română, Institutul de Geografie, Tipar Compania Sega International, Bucureşti, 280 p.

Dragotă, Carmen (2000), *Repartiția cantităților maxime de precipitații căzute în 24 de ore pe teritoriul României,* Alma Mater, Bucurestiensis, Seria Geographia, vol. IV, Edit. Universității din Bucureşti, p. 217-220.

Dragotă, Carmen, Bălteanu, D. (1999), *Intensitatea precipitațiilor extreme pe teritoriul României*, Rev. Geogr., VI, p. 12-14, 1 tab., 1 fig.

Lungu, M. (2009), *Fenomene climatice de risc din Dobrogea*, Editura Universitara, Bucuresti, 146 p.

Mihăilescu, I.F., Andreiaşi, N., Bucşă, I., Torică, V. (2001), *Fenomene climatice de risc din Dobrogea. Implicații ecopedologice şi economice,* Revista Geografică, Instit. de Geogr., Acad. Română, T VII, 2000 – Serie Nouă, Bucureşti, p. 178-185.

Niculescu, Elena (1997), *Extreme pluviometrice pe teritoriul României în ultimul secol,* SC Geogr., XLIV, p. 63-67.

Pătăchie, Iulia, Călinescu, Niculina (1973), *Cantități excepționale de pre-cipitații înregistrate în secolul XX pe teritoriul României*, Studii şi Cercetări Meteorologice, I.M.H Bucureşti.

Platagea, Gh. (1959), *Studiul ploilor torențiale pe teritoriul RPR şi influența lor asupra scurgerii,* MHGA, IV, 4, p. 21-28.

Săndica, Hîrsescu, Dragotă, Carmen (2005), *The coupling of the maximum precipitation, intensities with the maximum winspeeds in Dobroudja – an indicator to the management of the precipitation – wind climatic*, Analele Universității Ovidius – seria Geografie, Constanța, vol. I, nr.2, p.22-35.

Stăncescu, I., Goți, Virginia (1992), *Condițiile meteorologice care au determinat ploile deosebit de abundente din luna iulie 1991*, SC Geogr., XXXIX, p. 51-59.

Torică, V., Potra, Adelina. (2007), *The exceptional rain fallen in Constanta district end on the Black Sea coast on the 28th of August 2004*, Analele Univ. "Ovidius", Seria Geografie, Volumul 3, nr. 1, p. 138-143.

Topor, N. (1970), *Cauzele unor ploi cu efect catastrofal în România*, Hidrotehnica, XV, 11, p. 584-592.

Vasenciuc, Felicia, Dragotă, Carmen (1997), *Cantitățile de precipitații deosebite căzute în intervalul 28 martie-2 aprilie 1997 în partea sudică a țării*, mss., Comunicare, Sesiunea Şt., Univ. de Vest, Timişoara.