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CONSIDERATIONS REGARDING THE EXCEPTIONAL CLIMATIC VARIABILITY IN SOUTH-WESTERN ROMANIA IN 2013

Andreea Floriana Mărinică[1], Dana Maria (Oprea) Constantin[2], Ion Mărinică[3], Victor Viorel Vătămanu[4]

[1]Bachelor of Sciences, Klimacampus, Hamburg, Germany, *marinica.andreea@gmail.com*
[2]University of Bucharest, Faculty of Geography, Bd. Nicolae Bălcescu no 1, 010041, phone 021/3143508, Bucharest, Romania, danamartines@yahoo.com
[3, 4]Oltenia Regional Meteorological Centre, NMA, Str. Brestei no 3A, 200581, phone 0251/411711, Craiova, Dolj, Romania, Email ionmarinica@yahoo.com, victor.vatamanu@gmail.com

Abstract

Although the year 2013 has been classified as the sixth hottest year in history (WMO Michel Jarraud) at regional level, in South-western Romania the climatic variability was outstandingly marked by rapid changes from hot and dry to cold and rainy weather. Climatic alternations were recorded every month of the year. After the warm and whimsical summer, the autumn thermal regime was installed in South-western Romania. The fall of 2013 was marked by three intense cooling, one in late September continued to early October and culminated with low temperatures, negative thermal minimums and intense frost, which destroyed the vegetable crops. In November, the daily average high air temperature caused forced stages, by the end of month the crops were in advanced stages of development, signalled the emergence flower stems and buttons rape. Intense cooling weather and snowfalls recorded between 26 – 28.XI.2013 constituted a special climatic risk, surprising non-adapted crops with a strong chill of the weather. The snow reached 22 cm at Caracal in Romanatiului Plain. During the year there were 20 dry periods and 15 rainy periods or significant rainfall, from an agricultural point of view. The wettest month of the year was September with a monthly average for the whole region of 100.3 l/m^2, while the driest month was December with a monthly average of 2.9 l/m^2. As a result, the flow of water on the rivers and the levels had significant variations, affecting some areas with flood processes, pounding of water and erosion, and during periods of drought with lack of drinking water. Climate risk analysis in South-western Romania in autumn 2013 is a continuation of extensive studies on variability climate (Marinică, 2006; Sandu *et al*. 2012). It is a useful work for specialists, doctors, students and all those interested in the evolution of the climate.

Keywords: excess rainfall, drought, floods, intense cold weather, early snow.

1. INTRODUCTION

Within the 2013 period the weather developments in Oltenia and Romania and even at a continental level, in Europe, were atypical.

In this regard for Oltenia it is noticed:

- *massive cooling of the weather within the 25-28.III.2013 period* ,which brought back winter across the entire continent, and in south-western Romania (Oltenia), after 84 days with warmer weather than average, the snow layer on 28.III.2013 at 08 am, measured between 4 and 19 cm, considered the thickest in Romania at the respective date;

- *the extreme drought within the 10.IV-21.V.2013 time frame*, which lasted 40 days and affected the spring and autumn crops, determining *stages restraints in the south-eastern region for the barley yield* near the sandy areas of Olt county, and also began to ripen prematurely, severely affecting the production;

- this drought emerged immediately after *the period with torrential rainfall from 4-6.IV.2013*, which led to *flooding some areas of Oltenia* (on Jiu and Olt and their confluents);

- throughout the summer *three significant heat waves* were recorded which contributed to thermal maximums of near 40°C (the summer thermal maxima in 2013 was 39.8°C registered on 29.VII.2013 at Bechet);

- *at the end of each summer month, intense weather cooling occurred* which prompted the drop in temperatures below normal average values, therefore approaching the thermal regime of autumn;

- *at the end of September two days of torrential rains were recorded*, in which the weather cooled intensely. These led to precipitation quantities which surpassed 100 l/m^2, therefore *September 2013 was named the rainiest of the year* although usually this would be the second driest after February;

- *the weather cooling at the end of September continued and was accentuated during the first days of October 2013 reaching a climax on 5.X.2013* when the thermal minimum in the air recorded between -4.5°C

at Voineasa and 0°C at Dr. Tr. Severin, while at surface level these were among 0°C at Caracal and -4.7°C at Polovragi. This extreme cold destroyed enormous crops of unprotected vegetables;

- afterwards followed *a long interval of graduate warming of the weather* from 6.X.2013 up until 25.XI.2013, which established November to be a warm month, thus prolonging the optimal period of autumn crops until 25.XI.2013 (with a month more than the average period);

- *the substantial cooling of the weather arose due to the rainy period from 23-27.XI.2013 and especially from the night of 26/27.XI.2013 and shaped the settlement of a thermal regime specific for December beginning with the date of 27.XI.2013, and the occurrence of a snow layer* which in Oltenia had a thickness between 3 cm at Tg. Jiu and 22 cm at Craiova and Caracal, considered the thickest in the country on 28.XI.2013 at 08 am;

- the atypical weather persisted throughout December as well, which was excessively dry.

These climatic oscillations were reflected in the regime of water discharge, in the levels of lakes and underground aquifers, with important economic consequences. Henceforth we will analyse some of the extraordinary events which marked the climatic evolution of 2013, in south-western Romania.

2. METHODS

The data base employed for compiling this article is constituted by the meteorological observations recorded at the weather stations, with large arrays of data, for the south-western part of Romania, to which it is added the isobaric topography maps, which aided the statistical processing and interpretation of the achieved data.

3. RESULTS AND DISCUSSION

3.1 Abundant precipitations in south-western Romania during the 02 – 03.IV.2013 interval

Following the excessively rainy March 2013, within the 2-3.IV.2013 time frame, abundant precipitations were recorded which led to inundations on the rivers in Oltenia and alongside Danube. There were issued two weather warnings, stage yellow of precipitations for the intervals: 2.04.2013/11 pm - 3.04.2013/09 am and 3.04.2013/09 am – 4.04.2013/09 am and several hydrological warnings of yellow, red and orange alert for Jiu and its confluents and for Danube.

In Oltenia the average precipitations quantity recorded within the 2.IV.2013/08 am – 3.IV.2013/08 am time period (fallen especially at night on 2/3.IV) were of 11.1 l/m^2, while during the 3.IV.2013/08 am – 4.IV.2013/08 am interval the medium precipitations quantity measured by the weather stations was of 28.6 l/m^2.

The maximum amount of precipitations recorded in these two days were of 23.0 l/m^2 at Bâcleş in Mehedinţi hills on the first day, and of 97.8 l/m^2, respectively, at Cornet in Vâlcea county on the second day.

The total quantity of precipitations registered in these two days at the weather stations measured between 18.6 l/m^2 at Slatina and 64.6 l/m^2 at Polovragi and Tg. Logreşti, and in the mountain regions 73.1 l/m^2 at Ob. Lotrului, which represents in percentages ratios, values between 18.2% at Caracal and 129.5% at Tg. Logreşti compared with multiannual monthly averages calculated for the 1901-1990 interval.

The large amounts of precipitations, which frequently exceeded 50 l/m^2 were registered in the hills area, where the process of dynamic convection, owed to the interaction of air circulation with the underlying surface, was powerful.

Therefore, in Vâlcea county at 10 pluviometric stations out of 17 (which represents 58.8%), the precipitation quantities measured in the two days surpassed 50.0 l/m^2, whilst the maximum sum for the whole region was of 110.3 l/m^2 at Cornet on Latoriţa river, in Vâlcea county. The report and press statement of Vâlcea County's prefecture showed that in the morning of 4.IV.2014 a number of 11 localities, Rm. Vâlcea municipality inclusively, were affected by deluges, road erosions and electricity damages. *Floods occurred alongside Jiu River* in some areas (at Răcari) where the water level exceeded the height of inundations with over 1 m, and in several sectors with over 50 cm. In Dolj county 1 000 ha of crops were flooded, while in Mehedinţi county floods occurred in some parts. The harvest areas were covered by puddles on extended surfaces.

The torrential rains affected other counties across the country, and on 5.IV.2013 the Internal Ministry report states that over 140 de localities from 15 counties were affected by deluges, precipitations

triggering damages in 118 houses and wrecking 112 bridges and footbridges. Furthermore, 23 county roads and 30 communal roads were affected by floods in seven, eight counties correspondingly. More than 1 000 employees of the Ministry of Internal Affairs - cops, fire fighters and state officers with over 400 equipments: fire trucks, heavy machinery and motor-pumps, were provided for limiting the hydro-meteorological effects in 15 counties.

The drainage of waters and the rise in the discharge was amplified by the water melted from the consistent snow layer still existent in the mountain regions. At Ob. Lotrului, for example, in the morning of 4.IV.2013 the snow thickness measured 95 cm, whilst at Bâlea Lac was 254 cm.

The rainfalls in the first 5 – 8 days manifested in the Danube's catchment area imposed overflows alongside Danube starting with 8.IV.2013, urging the taking of some precautions, consisting of over-heightening the existent barriers and the building of additional barrages. Danube's water levels continued to rise, and on 13.IV.2013 at Galaţi reached the flooding elevation (600 cm). Displaying an almost latitudinal course (from north-west towards south-east) and crossing different climatic regions, the Danube can register important boosts in elevation and can generate inundations on its Romanian course sector even if Romania hasn't had significant precipitations quantitatively, even though the input of water discharge brought by the rivers on Romanian territory represents circa 29.0 % of the multiannual average discharge. Similarly to the inundations induced by the rivers from south-western Romania, the water delivered by the snow layers in the mountain areas of Danube's catchment basin, which in some areas reached the thickness of 168 cm, had a remarkable input in the increase of Danube's discharge.

In April throughout the south-western parts of the country rainfalls occurred up to 10.IV.2013, after which, for 41 de days, up until 21.V.2013 the drought was installed.

The synoptic cause of the torrential rainfalls from the 03 – 04.IV.2013 period were determined by a strong Mediterranean Cyclone initially formed in the Gulf of Lyon and which subsequently crossed over the territory of Balkan Peninsula and Romania following the classic pathway Vc (Fig. 1).

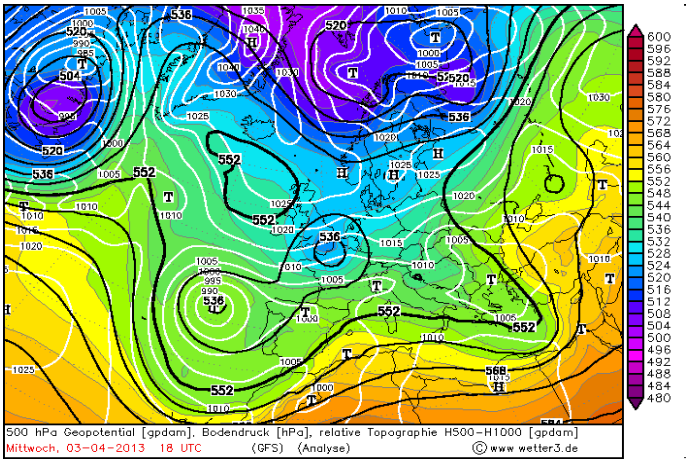

Figure 1. The synoptic state at ground level and in altitude, at the level of 500 hPa above Europe on 03.IV.2013 at 6 pm UTC

On the date of 03.IV.2013 at 6 pm GMT, it is observed that a vast cyclonic field with two nuclei operated over Mediterranean Sea and Atlantic Ocean. Hovering the Balkan Peninsula, the Mediterranean Cyclone displayed pressure values under 1005 hPa, while in the inferior troposphere, the air masses circulation was initially south-western, then southern and afterwards turning south-eastern (fig. 1) bringing over our country a maritime tropical (mT) air mass, humid, rich in water vapour. For the delivery of this extremely humid air mass contributed the fact that the surface water temperature of Mediterranean Sea at 04.IV.2013 measured between 13.0°C in the Genova Gulf area and 19.4 °C in south-east, values bigger than the multiannual averages for this date. Throughout the year 2013 and during the winter 2013 – 2014, the surface water temperature of Mediterranean Sea was maintained higher than the multiannual averages.

3.2 The spring drought within the 11.IV.2013 – 21.V.2013 time frame

Following the torrential downpours from the 03 – 04.IV.2013 time period, almost rapidly the precipitations diminished in intensity, with a limited coverage, becoming isolated and dim, allowing for the drought to set up. Gradually the weather warmed, and starting with 20.IV. 2013 the air temperature frequently exceeded 25.0 °C, often recording summer days. As a consequence of progressive

weather warming, the date of 30.IV.2014 registered the thermal maximums of April with values between 28.8 °C at Polovragi and 32.4 °C at Bechet, also allowing the development of broil phenomena, affecting the crops. The water reserve in the soil dropped drastically, and on 30.IV.2013 *in the soil layer 0 – 20 cm (fallow), the water accumulation displayed satisfactory values (AS) in the majority agricultural areas of the country. In Dobrogea, centre and eastern Muntenia, southern and locally in eastern Moldova, isolated in south-western Banat and southern Oltenia, was indicated a moderate pedological drought (SM) and locally prevailing* (Source Agro-meteorological Bulletin, NMA, 30.IV.2013).

The drought continued throughout the first 21 de days of May, the weather warming becoming more accentuated, while on the dates of 1, 19 and 20.V.2013 the May thermal maximums were registered, with values measuring between 28.4°C at Polovragi and 33.1°C at Calafat. Moreover, tropical and summer days were more recurrent, the water storage in the soil continued to drop, and on 20.V.2013, *the humidity reserve for the soil profile 0-100 cm, in the autumn barley harvest, was situated within satisfactory limits (AS) in Maramureş, Crişana, the largest part of Transilvania, western Muntenia, north-western Banat, Oltenia and Moldova. The moderate pedological drought (SM), strong(SP) and isolated extreme (SE) was occurring in Dobrogea, on extended agricultural areas in Oltenia, Muntenia, Moldova, Banat, centre and south-western Transilvania. The humidity content in the soil layer 0-50 cm, for the corn crops, presented small values (moderate pedological drought -SM) and excessively small (strong pedological drought - SP and isolated extreme -SE), across the majority crop fields. The soil water accumulation are considered within satisfactory limits(AS) and locally approaching optimal values (ApO), in Maramureş , most parts of Transilvania, Crişana, northern and centre Banat, north and isolated in southern and eastern Moldova, locally in north-western Muntenia* (Source Agro-meteorological Bulletin, NMA, 20.V.2013).

As a consequence of this intense drought event associated with high air temperatures, at soil surface, across harvest fields, the biological processes amplified in the largest parts of the territory. In the southern half part of the country, on account of extreme air temperatures and under conditions of great humidity shortages in the soil, not only for the autumn crops, but for the cultivated crops as well, the temporary withering of leaves was caused during afternoon hours, in addition to going yellow and enduring a partial scorching of the canopy. In southern Oltenia across the sandy areas for the barley harvest development restraints appeared, and on 18.V.2013 began the ripen process, whilst in some regions the plants were already dry, determining the loss of production.

Throughout this interval a drastic drop in the discharge and water elevations of the rivers occurred, while the water storage from the underground layers declined due to increased water consumption.

On Danube, due to the precipitations within the superior catchment area, as well as the sustained snow layer melting from the mountain regions, on 04.V.2013, the discharge of Danube's River while entering the country (Baziaş section), was of 10 200 m^3/s, which means it exceeded with 2 950 m^3/s the multiannual average of May. However in the last 10 days of April Danube's outflows recorded declines across the whole sector situated downstream of Porţile de Fier II Dam, which generated a diminution of water levels.

The warning elevations were maintained above normal values at hydrometric stations Calafat (550+3 cm), Bechet (550+47 cm), Corabia (500+31 cm), Turnu Măgurele (500+37 cm), Zimnicea (530+50 cm), Oltenița (550+17 cm), Feteşti (565+40 cm), Cernavodă (500+55 cm), Hârşova (580+22 cm), Vadu Oii (600+25 cm), Brăila (560+24 cm), Galaţi (560+5 cm), Isaccea (320+133 cm) and Tulcea (320+44 cm). Subsequently, during the 05 – 06.V.2013 time frame, the Danube discharge declined up to the value of 10 000 m^3/s and afterwards fell below this value (ABA JIU, 2013).

The synoptic causes of the drought within the 10-21.V.2013 interval were owed to the persistence of the anticyclone system over the large part of southern half of European continent. The Atlantic Cyclones displayed northern trajectories, maintaining a rainy weather across the northern half of Europe. This aspect is due to settlement of a positive phase of the North-Atlantic Oscillation.

As a consequence of this situation *in the first days of June* (the 04 – 05.VI.2013 period) a new outrush was formed on Danube, on the superior course of the river, in Germania and Austria, while on 05.VI.2013 the elevation at Budapesta was of 727 cm and was expected to reach on 10.VI the value of 885 ± 20 cm. At the Romanian entrance the Danube's discharge was still rising and was anticipated to surpass the protection levels, due to the propagated outrush, the maximum value estimated was of 10 500 m^3/s, and was supposed to be reached within the 13-15 June 2013 time frame.

All through the summer the climatic evolution continued to be oscillatory, therefore for every summer month was registered a heat wave, whilst at the end of each respective month a significant weather chill occurred. Therefore, the maximum air temperature was of 39.8°C recorded at Calafat on 29.VII.2013. Although the summer wasn't rainy, the registered precipitations throughout the summer generally occurred

„in an optimal timing" which maintained a good viability for the cultivated crops and determined the agricultural year 2012 – 2013 to be regarded fruitful from a „production outcome" standpoint.

The torrential rains return in the first autumn month, while September was considered the rainiest month of the year with an average for the entire region of 100.3 l/m^2, which constitute a climatic anomaly, September being in general the second driest month of the year after February. The same exception was applied in the case of February, being the fourth rainiest month of the year 2013 cu displaying a monthly average for the whole area of 77.5 l/m^2.

After the first 11 days of September with diminished precipitations, on 12.IX.2013 were registered the initial significant rainfalls from agro-meteorological standpoint, while in the last two days of September within the 29 – 30.IX.2013 time period were recorded *the most intense precipitations of year 2013*.

3.3 Abundant rains from south-western Romania from the 29 – 30.IX.2013 period

The total sum of precipitation quantities recorded during the two rainy days measured values between 36.5 l/m^2 at Voineasa and 126.8 l/m^2 at Drăgăşani with an *average for the entire region of 69.9 l/m^2*, which compared with the multiannual monthly averages, represents percentage ratios with values between 66.2% at Voineasa and 266.7% at Slatina.

The medium quantity of precipitations registered on *29.IX.2013* was of 32.5 l/m^2, while the amount of precipitations measured by the meteorological stations from Oltenia were among 9.8 l/m^2 at Calafat and 52.6 l/m^2 at Apa Neagră in the Subcarpathic region. The maximum quantity of precipitations registered for this date, was of 60 l/m^2 at Balta in Mehedinţi County.

On the date of 30.IX.2013 *the average amount of precipitations for the whole area* was of 37.4 l/m^2, considered *the biggest daily average for the whole region recorded throughout the year 2013*.

The maximum amount of precipitations measured for this date, was of 75.2 l/m^2 at Drăgăşani, in Vâlcea county.

There were issued weather warnings, yellow stage of torrential rains for the largest part of the Romanian southern half, whilst for south-eastern Muntenia and Dobrogea an orange alert was released.

As a result of the torrential rains in several regions of the Romanian southern half inundations occurred, for example the events in Galaţi County, where the floods of September 2013 affected 39 localities. There were destroyed 227 houses and a staggering number of 3 443 homes suffered damages. Furthermore, landslides in several regions of Romania were revived.

The water puddles across the harvest areas and the humidity excess in the soil au lead to a delay in harvesting the autumn crops.

The synoptic causes of the abundant downpours from the 29 – 30.IX.2013 interval were generated by a Mediterranean Cyclone, formed as a consequence of a very rapid cyclogenesis in Genova Gulf. The Mediterranean Cyclone trajectory was of the classic type Vc (Fig. 2).

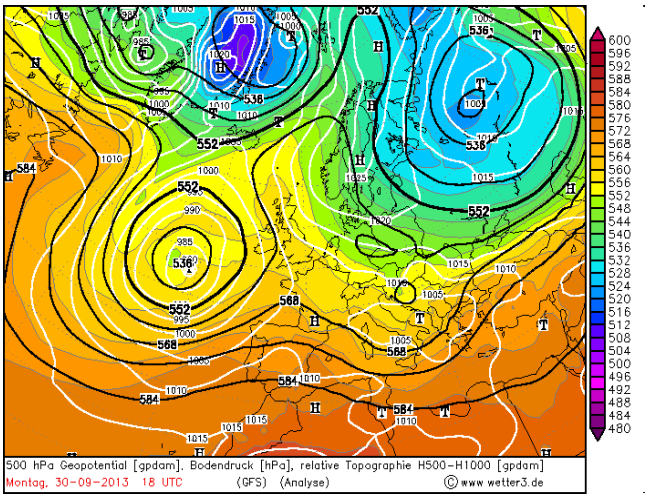

Figure 2. The synoptic state at ground level and in altitude, at a level of 500 hPa above Europe on the date of 30.IX.2013

The air mass which influenced Romania within this interval was a tropical maritime mass (mT) advected above the Mediterranean Sea by the south-western circulation then southern and finally south-eastern in the inferior troposphere. In altitude it is observed an atmospheric circulation of blockage for

Western Europe, which contributed to a double input of humid air, rich in polar maritime water vapour (mP,) as a result of altitudinal north-western circulation, NAO being in its negative phase.

4. CONCLUSIONS

Throughout 2013 the climatic variability in Romania, similar to the entire continent and northern hemisphere, was exceptional. Consequently, climatic alternations were registered in each month of the year. Following the warm and whimsical summer, the autumn thermal regime was installed in south-western Romania. The autumn of 2013 was marked by three intense weather chills, one at the end of September which lasted until the beginning of October and culminated with low temperatures, negative thermal minimums and severe frosts, which destroyed the vegetable crops. In November the soaring daily averages of air temperatures led to stages enforcing for the development process, while by the end of the month, the autumn crops appeared to be in advanced stages of growth, while the canola crops signalled the emergence of flower stems and buttons rape. The intense weather cooling and snowfalls registered within the 26 – 28.XI.2013 time frame constituted a significant climatic risk, startled the crops unequipped for the severe weather cooling. The snow layer reached 22 cm at Caracal in Romanaţiului Plain. All through the year, 20 dry periods and 15 rainy events or with significant precipitations were registered, from an agricultural standpoint. The wettest month of the year was September with a monthly average for the entire region of 100.3 l/m^2, whilst the driest was December with a monthly median of 2.9 l/m^2. As a consequence, the discharge and water levels on rivers presented important variations, affecting some areas with inundation processes, water puddles and erosions, and during the drought periods with the lack of drinking water. *The outflows, high elevations and floods on Danube* occurred in the first part of the year (Fig. 3), owned to the spring precipitations and water released by the snow layer.

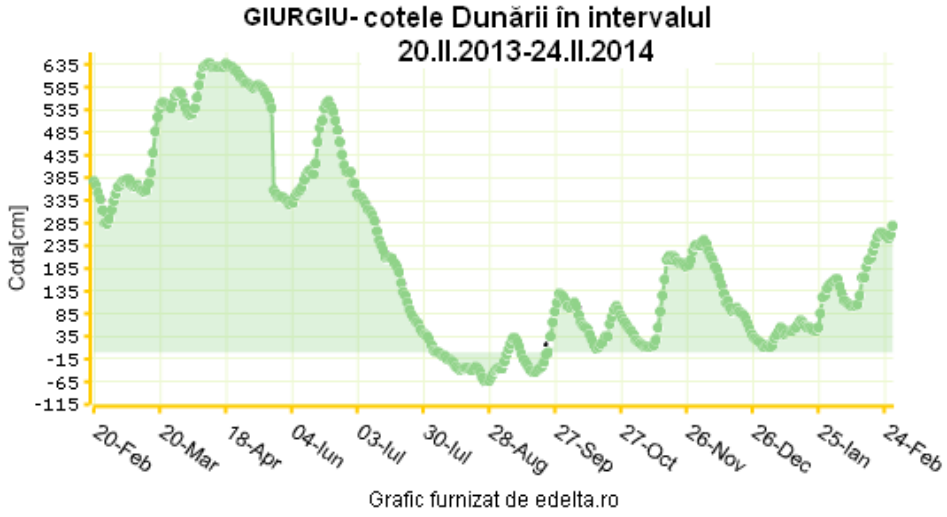

Figure 3. Danube levels at Giurgiu, within the 20.II.2013 – 24.II.2014 interval

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