MONITORING AND EARLY-WARNING OF METEOROLOGICAL RISK SITUATIONS IN OLTENIA

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ABSTRACT. – Monitoring and early-warning of meteorological risk situations in Oltenia. Among the natural hazards affecting the human well-being and properties, meterological events are first to come in mind, due to their frequency, (immediate) effects and (improving) predictability. Assesment of these components are the first step in risk management, when the knowledge on the hazard type and characteristics is essential for defining the vulnerability and exposure and thus for preparing the mitigation plans. The spatial scale of dangerous meteorological situations is, in most cases, the regional one, but sometimes the area of major intensity or even the area of manifestation is small enough (e.g. hail, heavy rain showers) to be classifed as ‚local'. Furthermore, other factors like the local geographical features, population density, goods and properties at risk (e.g. cultivated areas, buildings, infrastructure etc) come into play in defining the severity of the weather event and/or the needs for interventions aiming to reduce the effects of the weather situation. In this context, the monitoring of potentially dangerous meteorological conditions and the improved forecasting capabilities and accuracy become increasingly important. In this paper, we present a short overview of the severe meteorological events affecting the Oltenia region along with aspects regarding their monitoring, early-warning and socio-economical impact in the area of interest, with a focus on the Dolj county during the 2013-2015 period.

Keywords: meteorological hazards, early-warning, socio-economic impact.

1. INTRODUCTION

Known in medieval times as Wallachia Minor, Oltenia is one of the 8 Development Regions of Romania - the South West "Oltenia" Region, with nearly 2.1 million inhabitants, bordered by Danube River to the South and by Carpathian Mountains to the North. It is divided into five different counties (Dolj, Olt, Gorj, Mehedinti, Valcea), with Craiova as the unofficial capital of the region. The economy of the region is based both on the industry (largest contribution to local GDP) and on the agriculture (largest share of population working in this area) [1]. The region has mainly a rural character, as 48% (and decreasing) of population lives in urban areas, half of which have less than 10 000 inhabitants. These aspects highlight the vulnerability of the region to the natural hazards, including those related to severe weather conditions.

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The monitoring and forecast of meteorological conditions are among the main activities of the National Meteorological Administration (MeteoRo), which, as acknowledged by the law 281/2015, performs activities of national interest, relevant for the national security and defence. When these conditions present a potential threat to human lives, properties and/or activities, MeteoRo issues warning messages regarding the onset, the intensity and the expected evolution of the forecasted meteorological phenomena. The warning procedure is governed by law [2]. This states that there are 9 meteorological phenomena which may trigger meteorological warnings: strong wind, liquid and solid intense precipitation, lightning, blizzard, extreme low /high temperatures, glazed frost and fog. The warnings have several (three) intensity levels, defined in relation to the intensity of the phenomenon, the local climatology (e.g. for the region considered) and the potential/expected impact (damages, etc.). The warnings are coded through colours - yellow, orange and red, the last being associated with the strongest negative (damaging) impact. The colour code of these warnings is highly popularized in terms of potential impact - it is presented on MeteoRo website, associated/explained along with each warning both by the MeteoRo and by the media - such that to activate a rapid response from the authorities and from individuals as well. The informational flux is also regulated (governed) by law; - this foreseen that for meteorological phenomena with regional manifestations, the regional meteorological centers (MeteoRo branches in the territory) will transmit the warnings to local/regional structures for the management of emergency situations.

Regional Meteorological Center Oltenia (CMR-OL) is the MeteoRo branch for the SW part of Romania. CMR-OL manages observational data from 18 meteorological stations and 1 meteorological radar (Fig.1).

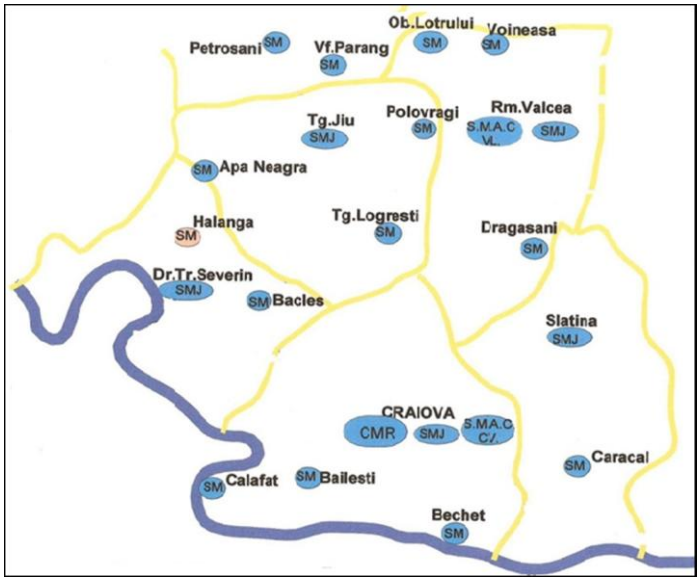


Fig.1 ***Area coverage and main meteorological stations managed by the Regional Meteorological Center Oltenia.***

CMR-OL provides the weather forecast for the region for 3 time-intervals – very short range (nowcasting; up to 3 hrs), short range (1-2 days) and medium range (4-7 days); it also collaborates with the National Weather Forecast Center from Bucharest, as well as with the other 6 regional centers, to elaborate the weather forecast at national level.

Oltenia, just like the rest of the territory, is prone to meteorological hazards (e.g. strong winds, heatwaves, heavy precipitation) or manifested as a consequence of these (e.g. landslides, flashfloods). The quite substantial vulnerability of the region, given by the feeble economic development (6th-8th place of EU regions with the lowest GDP [3]) and response capacity, require an adequate monitoring and an efficient early-warning system of (meteorological) dangerous situations in order to reduce the unfavorable consequences on human life, properties and activities.

In this paper, we aim to present a short overview of severe weather events and associated phenomena affecting the Oltenia region, along with aspects regarding their monitoring, early-warning and socio-economic impact in the area of interest, with a focus on the Dolj county during the 2013-2015 period.

2. DATA AND METHODOLOGY

We used a diversity of data sources to characterize qualitatively and quantitatively the meteorological risk situations, as well as their socio-economic impact, which affect the Oltenia region, with a particular focus on Dolj county. A qualitative description of the occurrence and the impact of such phenomena are provided by the reports on severe weather events, based mostly on non-standard reporting sources (newspapers, eye-witnesses, volunteers) available from the European Severe Weather Database [4]. The long-term standard measurements and observations realized at the meteorological stations located in Dolj county (Craiova, Calafat, Bailesti, Bechet) provide the basis for the analysis of interest events occurrence and their intensity in this area. Information regarding the economic impact in agriculture is available from the public reports of Agricultural Direction of Dolj county, while information on the social impact is provided by the data from the Inspectorate for Emergency Situations in Dolj county, in terms of number of on-site interventions in meteorological-related cases. The data are analysed mainly at annual scale, in specific cases using threshold values for relevant meteorological parameters as foreseen by the legislation (e.g. extreme temperatures).

3. OVERVIEW OF SEVERE WEATHER EVENTS AFFECTING OLTENIA REGION

Among the dangerous weather phenomena manifesting in the Oltenia region there are worth noting, due to their frequency and socio-economic impact, the heat/cold waves, intense precipitation (rain and snow), hail and strong winds. For example, based on the information available in the European Severe Weather Database, only during the period 2000-2015 more than 90 severe weather events

have been reported as affecting this region (Fig. 2). Most of these were characterized by limited spatial manifestation (local character) and short duration. The largest part of the events reported is related to heavy precipitation (43%) and hail (33%). A suggestive example for the last phenomenon is the event of 25 May 2013 in Olt county, when the hailstones reached up to 3.5 cm and the layer on the ground was about 10 cm high; the event had a strong impact on agriculture, as about 16 000 hectares of cultivated lands were affected (Cica et al, 2015).

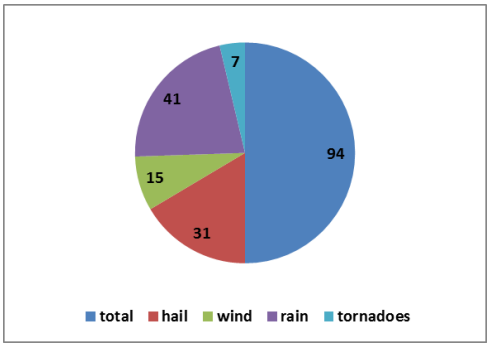


Fig. 2. ***Occurrence of main (local, short-term) severe weather events reported in the Oltenia region during the period 2000-2015 (source: www.eswd.eu)***

Strong wind situations are developed in specific synoptic configurations. One such synoptic situation, of interest for the Oltenia region, is associated with the jet stream related to the polar front, which generates sustained wind intensifications in almost the entire region. A recent example is the event on 22-24 March 2013, when yellow and orange-color code warnings have been issued for the SW Oltenia due to strong wind, the wind gust reaching 24 m/s at Calafat station during this interval (Lupascu et al, 2013); Dolj county was strongly affected, 22 communities being out of electrical power on the first day (22 March) [7]. The strong wind situations in Oltenia may take even the aspects of a tornado (Antonescu and Bell, 2015) although their frequency in this region is very low.

The extreme temperatures situations represent another class of weather events affecting the Oltenia region. The most intense event was the heat wave of 2007, when the record temperature of 44.3 ^{o}C was measured on 24.07.2007 at Calafat, being only 0.2 ^{o}C below the absolute maximum temperature ever recorded in Romania (at Ion Sion meteorological station in 10 August 1951). The situation triggered (led to) a red-code warning from NMA, being the first of this kind in Romania. This extreme weather episode, which lasted for more than 10 days in Oltenia, lead to 30 deaths [9] and about 19 000 people were hospitalized [10]. At the other end of the spectrum there are the very cold temperatures, which also have a major impact on human health. In this respect, a recent example is the winter of 2012, with -28.9 ^{o}C recorded at Bailesti station on 1.02.2012, this being the absolute minimum temperature at this station since 1981 and very close to the record of low temperatures measured in Oltenia in the period 1981-2010 (-30 ^{o}C at Apa Neagra, on 13.01.1985). The very low temperatures during the above-mentioned episode in the winter of 2012 were preceded /succeeded by heavy snow and blizzard, the severe meteorological conditions triggering several yellow and orange-color

warnings in a large part of the country, including Oltenia. The weather conditions lead to 86 deaths and more than 7500 people affected in the entire country [9].

It is worth noting that only during the last 3 years (2013-2015) CMR-OL issued more than 900 nowcasting warning messages for weather phenomena presenting a potential risk for population and human activities (Fig. 3). These warnings brought into attention conditions like intensification of some on-going phenomena (e.g. for strong wind situations), manifestation of short-term phenomena affecting certain activities (e.g. fog, glazed frost), or prolonged unfavorable conditions for human health and activities (e.g. hot/cold weather prolonged rainy temporal intervals).

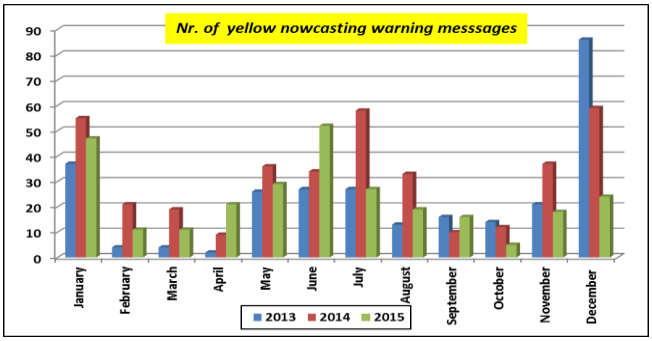


Fig. 3 ***Number of yellow nowcasting warning messages emitted by the Regional Weather Forecasting Center within MeteoRo-CMR Oltenia, for the Oltenia region, in the period 2013-2015 (data from internal reports of MeteoRo-CMR Oltenia).***

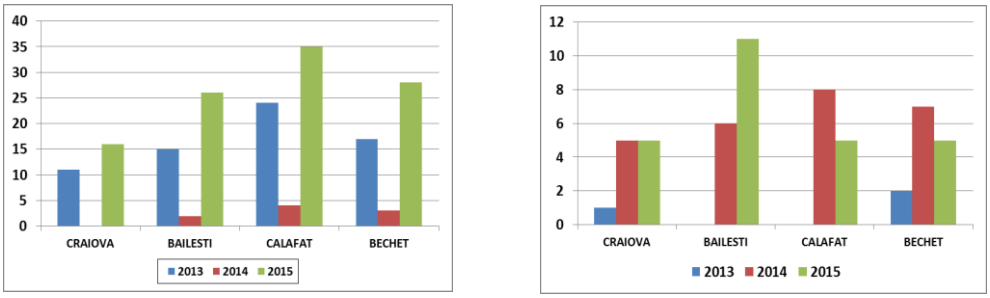
The severe weather events are, in some cases, associated with other hazardous environmental situations, like floods, land-slides, soil erosion. As an illustration, the floods from April 2006 heavily affected Dolj, Mehedinti and Caras-Severin counties (more than 1400 households and 100 socio-economical units flooded) [11]. The floods were caused both by meteorological phenomena (intense precipitation in the upstream sector of the Danube, sudden weather warming which led to snow melt) as well as other factors like dams low resistance, unsuitable planning and (households) development of some villages etc. In such cases, NMA contributes to the management of the emergency situation through the careful and continuous monitoring and forecast of meteorological conditions, as part of the emergency management structure.

4. METEOROLOGICAL RISK SITUATIONS IN DOLJ COUNTY DURING THE 2013-2015 PERIOD

The period analysed highlights the changing character of weather and its ample impact on the human activities. While the meteorological conditions made 2013 a favourable year for agriculture [12], in 2014 significant financial help was paid by the national authorities to farmers, as support for the losses due to weather (rain, drought, unfavourable temperatures). The year 2015 brought some losses to agriculture as well, but it was more remarkable due to the high temperatures during summer.

In Dolj county, almost 40% of days during the warm season (May-September) were characterized by canicular weather conditions - with maximum air temperature exceeding 35^{o}C (Fig 4a). Only the year 2015 presented 105 canicular days from the total of 181 cases recorded during the period 2013-2015.

The high temperatures triggered several yellow and orange warnings during July and August 2015 and activated the emergency measures foreseen by law and implemented by local authorities. The opposite weather conditions - very cold (freezing) nights, defined by minimum temperatures below -10°C, where also more frequent during 2015, with 11 cases recorded at Bailesti station (Fig 4b).



(a) **(b)**

Fig.4 ***Annual number of (a) canicular days (Tmax ≥ 35°C) and (b) freezing nights (Tmin ≤ -10°C) for the 4 meteorological stations in Dolj county during 2013-2015.***

Associated with the high temperatures during summer, the wild fires on dry vegetation represent, unfortunately, an environmental risk situation of interest in Dolj county. The data provided by the Inspectorate from the Emergency Situations of Dolj county show that during 2015 the number of such cases almost doubled compared to 2013 (Fig. 5). The fires affected significant areas –for example only during the period 07.08 – 10.08.2015, there were 26 interventions in Dolj county for extinguishing of wild fires, these affecting a total area of 455 hectares [13].

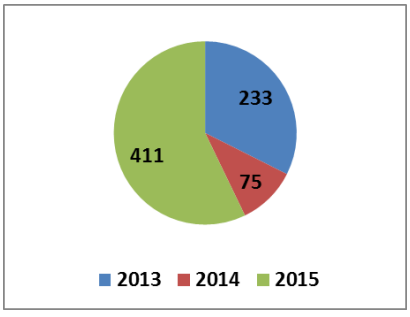


Fig. 5 ***Number of wild fires (dry vegetation) within Dolj county during the 2013-2015 period (source: Inspectorate for Emergency Situations of Dolj County).***

Intense precipitation is another potentially dangerous weather phenomenon relevant for Dolj county during the period analyzed. Overall, 224 days with 24 hr-cumulated precipitation exceeding the seasonal warning thresholds were recorded at all meteorological stations from Dolj county (Fig. 6a). The heavy precipitation events during 2014 (44% of the total number of days during 2013-1015), in some cases associated with hail (4 cases at meteorological stations in Dolj) brought significant losses in agriculture; the authorities provided, to farmers from Dolj, financial help of about 346000 EUR for

damages in the vegetable sector (4524 hectares affected), 10 000 Euro for closed cultivated spaces affected by hail and about 65000 EUR in the beekeeping sector [14].

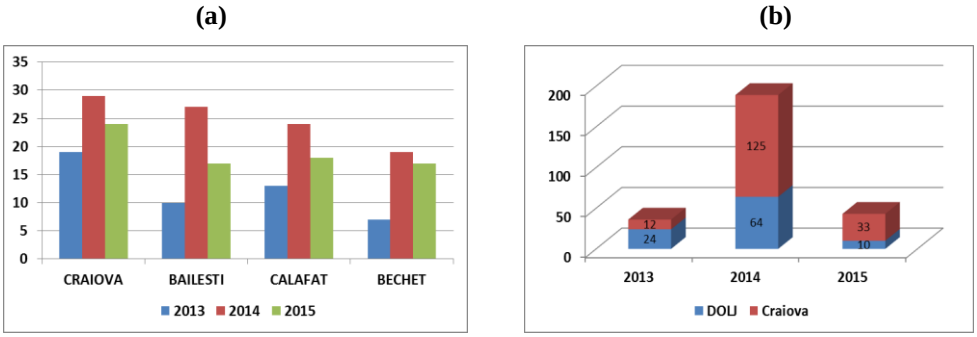


Fig. 6 (a) ***Number of days with daily precipitation exceeding the seasonal warning threshold value, for the 4 meteorological stations in Dolj county; (b) Number of on-site flood-related interventions of the Inspectorate for the Emergency Situations in Dolj county (blue) and in the urban area of Craiova (red) during 2013-2015 period.***

Heavy precipitation can disturb the activity of certain economic sectors, but the most damaging consequences are produced by floods –situations when the precipitation plays a major role, along with local factors both of natural and anthropogenic nature. In Dolj county, the Inspectorate for the Emergency Situations had 268 interventions related to floods during 2013-2015 (Fig. 6b). As expected, the largest part (70%) was needed during 2014, when hydro-meteorological conditions required far more warnings (270) than during the previous year (167) [15]. Most of the flood-related interventions were within the urban area of Craiova, where the denser population contributes to a more pronounced vulnerability to unfavorable meteorological conditions.

5. DISCUSSIONS AND CONCLUSIONS

We presented a short review of severe weather events and associated phenomena affecting the Oltenia region. The attention focused mainly on short-term events, due to their immediate effects and long-lasting impression on the community memory; at the same as their forecast has a high accuracy which allows a rapid response for mitigation of their effect on the socio-economic activity and human well-being. Other weather-related dangerous situations, like droughts and soil erosion, manifested on longer timescales, are equally relevant for the area considered, although not examined here.

Given the potential disastrous effects of weather conditions, substantial efforts are made to develop operational warning systems and effective preparedness measures. MeteoRo is involved in national and international projects aiming to improve the performance of its activity –both through research and by enhancing the capabilities of the monitoring network [16]. A recent example for the latter is the modernization of surface meteorological stations through the project financed within

the Sectoral Operational Programme Environment (POS-Mediu) 2007-2013, 3 of the new stations being located in Oltenia region. At regional level, CMR-OL collaborates closely with the structures for the management of emergency situations and it is also involved in the community life by contributing to raise the public awareness toward the dangerous meteorological situations.

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