August 27-31, 2023
FLORENCE - ITALY
ICWE 16
16th International Conference on Wind Engineering

Wind damage catalogue of Romania 2013-2022: an overview

Ileana Calotescu [1], Adriana-Silviana Chitez [2], Marius-Victor Bîrsan [3]

[1]*Technical University of Civil Engineering Bucharest, Bucharest, Romania, ileana.calotescu@utcb.ro*
[2]*Cardiff University, Cardiff, United Kingdom, ChitezA@cardiff.ac.uk*
[3]*Ministry of Environment, Waters and Forests, General Directorate for Impact Assessment, Pollution Control and Climate Change; Climate Strategies and Reporting Department, Bucharest, Romania. marius.birsan@gmail.com*

SUMMARY:
This abstract introduces a Wind Damage Catalogue of Romania compiled based on 10 years of damage data collected from mass-media crowdsourcing. A total number of 228 wind damage events have been identified, an event being defined by the day of occurrence and the location of damage. Two main objectives were followed within this work, namely to identify the country regions where most thunderstorms occur and to assess the most frequent type of structural as well as and non-structural damage produced by wind. Results show that most thunderstorms have occurred in the western part of the country followed by the northern regions. Moreover, hourly wind data provided by Meteo Romania show that the largest gust speeds were recorded at stations located in the West, i.e., Transylvania and Banat regions. The information gathered about the damaged building structures point out that blocks of flats and family houses are the most affected by the strong winds, mainly at roof level. Non-structural damage consisted mostly of broken trees and cars damaged by debris.

Keywords: wind-induced damage, wind damage map, thunderstorm velocity map

1. INTRODUCTION

This abstract introduces a wind damage catalogue of Romania that was elaborated based on 10 years of damage data (2013-2022) collected from mass-media reports (Calotescu and Chitez, 2022). The purpose of the catalogue is twofold. First, this work represents a preliminary step in the identification of zones across Romania affected by thunderstorm winds. This was done based on hourly gust speed data provided by Meteo Romania (Romania's National Meteorological Administration) for each event. Second, cataloguing wind-induced and wind related damage has allowed to assess the most frequent type of structural as well as non-structural damage produced by wind and hail in Romania.

Thunderstorm winds typically produce damage to low and medium-height structures such as transmission towers (Calotescu and Bîrsan, 2021), family houses or blocks of flats, the latter one being affected mostly at roof level (Tamura, 2009). Claddings of tall buildings or roofs of long span structures are also commonly damaged during strong convective events (Loredo-Souza et al., 2019). Damage sustained by the natural environment may be induced either by strong winds as in the case of forest windthrow (Suvanto et al., 2016) or by large hail accompanying thunderstorms which usually affect crops (Zhou et. al, 2016).

2. METHODOLOGY

The data used for the purpose of this research was collected via mass-media crowdsourcing from both local as well as national newspapers. The extensive search was done by employing the Google search engine and setting different keywords such as "*strong storm*" or "*damage produced by thunderstorm*" together with specific dates. As this research focuses on thunderstorm induced-damage, only the months March to September were selected for each of the investigated years (2013-2022). These months correspond to the thunderstorm season in Romania. As a threshold for the damage type, the selection of wind damage events was performed such that to include only those for which at least tree damage was reported. Moreover, only wind-induced and/or hail-induced damage was taken into account. The collected data consisted in the exact date of the event, an event narrative, the number of injuries and deaths, the cause of damage (wind or hail) and the type of structural and non-structural damage.

3. THE WIND DAMAGE CATALOGUE

The Wind Damage Catalogue of Romania comprises 228 wind damage events that were identified between 2013 and 2022. Table 1 shows both the annual number of wind damage events and the annual number of days with windstorms that have occurred within the investigated timeframe.

Table 1. Annual number of wind damage events and days with windstorms

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
No. of wind damage events	13	25	17	18	59	13	18	10	17	38	228
No. of days with windstorms	10	12	11	13	13	8	13	8	11	25	124

3.1. Wind-damage prone regions

The data on damage location for each event was used to compile the map of damaging winds presented in Figure 1. It may be noticed that most wind damage events have occurred in the western part of the country, namely Banat and Transylvania regions followed by the northern part. This result is in agreement with Iliescu (1989) who concluded that the effect of the relief of the Carpathian Mountains favorizes the thunderstorm activity in the western part of the country.

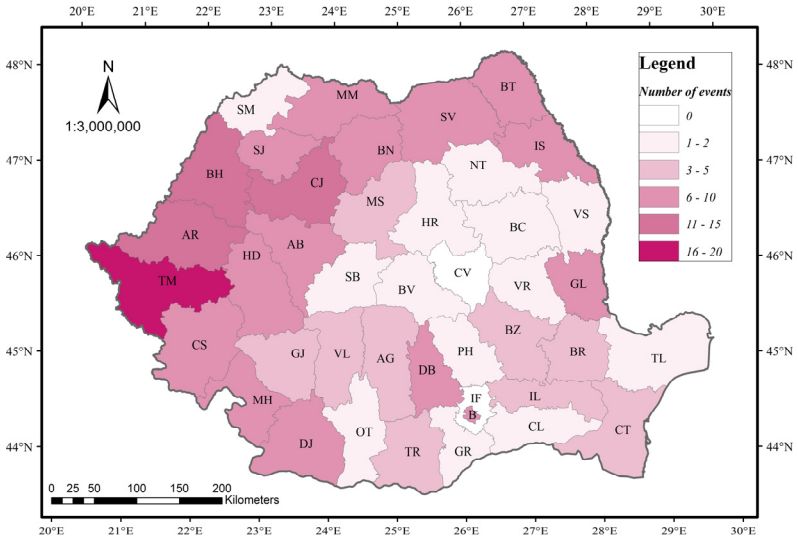

Figure 1. Map of damaging winds 2013-2022 (Calotescu and Chitez, 2022).

3.2. Wind-induced and wind-related damage

The most frequent type of damage is reported in Figure 2 in terms of percentages of total number of events for each category. Blocks of flats and family houses are the most common types of structures affected by the strong wind, the damage being located mostly at roof level (Fig. 2a). Electricity poles collapsed due to wind in 20% of cases, whereas traffic signs or billboards suffered damage in about 8% of the events. In 4% of wind damage events either transmission or telecommunication lattice towers collapsed (Calotescu and Bîrsan, 2021). Non-structural damage consisted mainly in broken trees and cars damaged by debris (Fig. 2b).

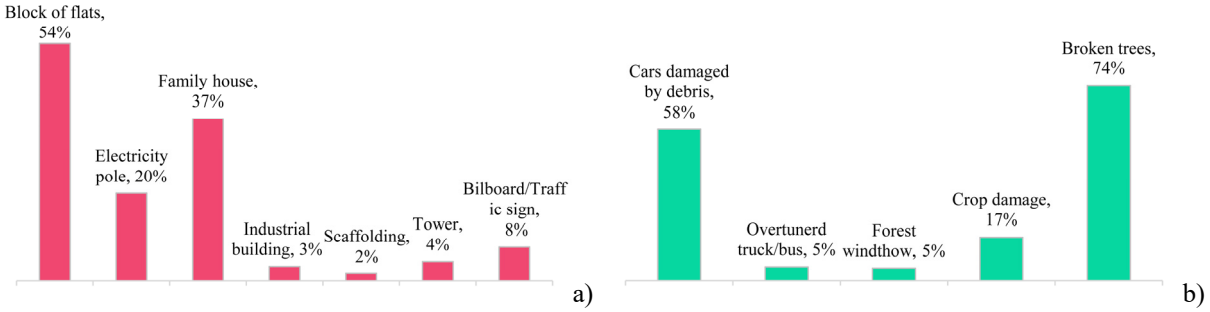

Figure 2. Structural (a) and non-structural (b) damage produced between 2013 and 2022.

4. WIND VELOCITIES ASSOCIATED WITH THUNDERSTORM RECORDS

Wind data was made available by the National Meteorological Agency of Romania for 9 out of the 10 years investigated within this research (2013-2021). Out of the 228 wind damage events, 188 were categorized as thunderstorm records based on visual inspection of the hourly gust speed time series. Thunderstorm records were considered those for which the patterns of hourly gust speed time series resembled those shown in Figure 3a, which emphasizes a sudden increase in gust speed together with a change in direction. Records that showed a steady increase in gust speed with each hour and no change in wind direction were assumed as depression records (Fig. 3b).

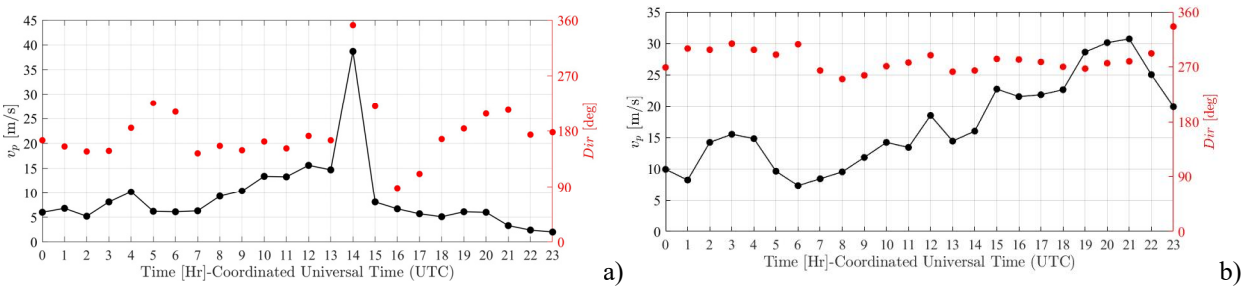

Figure 3. Patterns of gust speed records: thunderstorm record (a) and depression record (b).

Figure 4 shows the maximum gust speeds recorded at the meteorological stations located nearby the location of damage for each of the 188 events categorized as thunderstorms. The largest gust speeds were recorded in the West, with values mostly between 30-35 m/s. It is to be noted that these values are much larger than those provided by current wind design code in Romania (CR1-1-4/2012) for the specified region, i.e., 25-28 m/s. As such, it is clear that in future wind design codes, a thunderstorm hazard zonation map will need to be implemented.

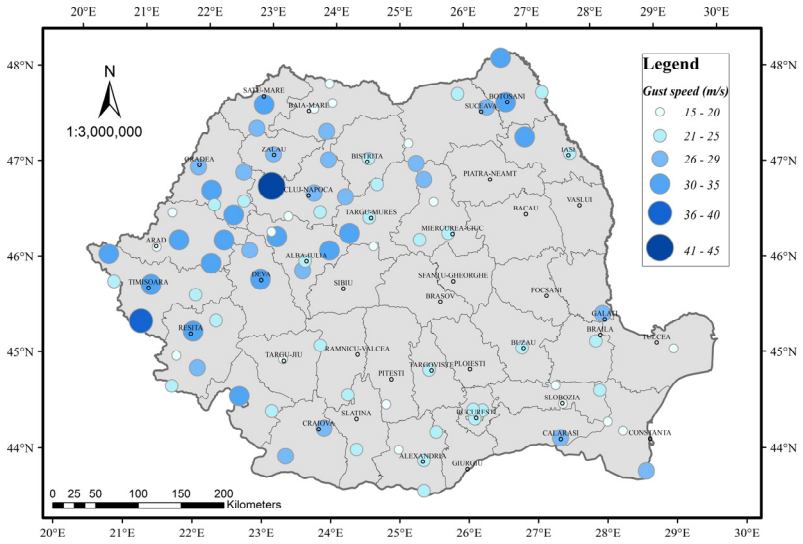

Figure 4. Maximum gust speeds associated with thunderstorm records (2013-2021).

5. CONCLUSIONS

We presented a wind damage catalogue of Romania elaborated based on 10 years of damage data obtained from mass-media crowdsourcing. Two main results were presented. First, a zonation of thunderstorm occurrence which showed that during 2013-2022 in the western part of the country a larger number of thunderstorms have occurred than elsewhere. Moreover, the wind data provided by Meteo Romania (National Meteorological Administration) showed that the most intense gust speeds were recorded at western meteorological stations. Second, data on damage showed that blocks of flats and family houses were the most affected types of structures, whereas non-structural damage consisted mainly in broken or uprooted trees and cars damaged by debris. This study will contribute to the elaboration of a thunderstorm hazard map for future Romanian wind design codes.

ACKNOWLEDGEMENTS

The research presented herein was carried out under the "HAZCON" research grant (https://hazcon.utcb.ro/), code UTCB-CDI-2022-014 financed according to the provisions of the Order of the Ministry of Education no. 3, 126 / 11.02.2022, published in the Official Gazette of Romania no. 179 / 23.02.2022.

REFERENCES

Calotescu I. and Chitez A.S., 2022. Wind Damage Catalogue of Romania 2013-2022, Editura Conspress, Bucuresti.

Calotescu, I. and Bîrsan, M., 2021. Damage to transmission towers under thunderstorm winds. ce/papers, 4: 283-288.

Cod de proiectare. Evaluarea acțiunii vântului asupra construcțiilor (*Design code. Assessment of wind action on structures*). Indicativ CR1-1-4/2012.

Iliescu, M.C., 1989. Manifestări electrice atmosferice pe teritoriul României (*Atmospheric electrical manifestations over the Romanian territory*), Editura Academiei Republicii Socialiste România. (in Romanian)

Loredo-Souza, A.M., Lima, E.G., Vallis, M.B., Rocha, M.M., Wittwer, A.R. and Oliveira, M.G.K., 2019, Downburst related damages in Brazilian buildings: Are they avoidable? J. Wnd. Eng. and Ind. Aerody. 185, 33–40.

Suvanto, S., Henttonen, H.M., Nöjd, P. and Mäkinen, H., 2016. Forest susceptibility to storm damage is affected by similar factors regardless of storm type: Comparison of thunder storms and autumn extra-tropical cyclones in Finland. Forest Ecology and Management 381, 17–28.

Tamura, Y., 2009, Wind-induced damage to buildings and disaster risk reduction, The Seventh Asia-Pacific Conference on Wind Engineering, November 8-12, 2009, Taipei, Taiwan.

Zhou, J., Pavek, M.J., Shelton, S.C., Holden, Z.J. and Sankaran, S., 2016. Aerial multispectral imaging for crop hail damage assessment in potato. Computers and Electronics in Agriculture 127, 406–412.