Characteristics of the Hănești tornado

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ABSTRACT: The study of tornadoes on the territory of Romania is recent. That is why we turned to American geographical literature, utilizing the Enhanced Fujita (EF) scale which represents the intensity of tornadoes in the United States of America (2007) as well as Canada (2013) based on the damage they cause (damage indicators, or DI). Each damage indicator is correlated with a particular estimated wind speed, depending on their degree of damage (DoD), and lastly the tornado is associated with the maximum intensity of all indicators. Six damage indicators have been analysed. In the case of the last two (27 and 28) it can be clearly seen that wind had reached speeds of 128 - 134 mph, equivalent to 206 - 215 km/h. This means that the tornado that occurred in Hănești was an EF2, being in the interval of 178 - 217 km/h (111 - 135 mph).

KEY WORDS: tornado, Hăneşti, Enhanced Fujita Scale.

1. Introduction

The occurrence of the meteorological phenomenon of tornadoes in Moldavia was mentioned by the writer Mihail Sadoveanu in his novel, "Hanu Ancuței", the actual time of events being identifiable in the text as the year 1853. Until the Făcăeni tornado (Ialomiţa County), produced on the 12th of August 2002, it was posited that tornadoes do not occur on the territory of Romania. Meteorological researcher Leslie R. Lemon studied this tornado using American parameters and classifies it as an F3 on the original Fujita scale, claiming that "Once a strong tornado occurs in Romania, others of similar intensity may occur at any time". The purpose of this study consists in the scientific research of this meteorological phenomenon (that is wholly unknown to laypeople and which on the 11th of July 2014 destroyed a quarter of the commune of Hănești), the dissemination of information on the presence of tornadoes in Botoșani County, and the offering of preventive advice to institutions so as to ensure people's safety during and after the occurrence of tornadoes.

2. Methods

2.1. The preparatory stage

The preparatory stage consisted in the study of reference material, as well as the selection and synthesis of information. We turned to American geographical literature, utilizing the Enhanced Fujita (EF) scale which represents the intensity of tornadoes in the United States of America (2007) as well as Canada (2013) based on the damage they cause (damage indicators, or DI).

The Enhanced Fujita scale is a set of wind estimates (not measurements) based on visible damage, using three-second gusts estimated at the point of damage based on 8 levels of damage and 28 indicators. These estimates vary depending on height and exposure, and are not identical with measurements from weather stations.

2.2. The field stage

The field stage was performed itinerantly, immediately after the occurrence of the phenomenon, in the commune of Hănești with the help of local authorities, and consisted in the production and acquisition of materials such as photographs, video recordings, accounts from locals regarding the events of 11th of July 2014. The methods of mapping and itinerant observation consisted in the delimitation of the affected area (length, width), particularly the affected households and outbuildings.

Data collection was performed stationarily after the completion of the inventory sheet of damaged households in the commune of Hănești as a result of the meteorological phenomenon on the 11th of July 2014 between 12:58 PM and 13:00 PM, approved by the Botoșani County Prefecture.

2.3. The data processing stage

The data processing stage was based on computer methods (GIS), involving number processing (statistical tables and calculations), Internet usage, and the creation of graphs and maps. The atmospheric conditions that formed the basis of the tornado's formation were found by processing data taken from the nearest weather station, specifically that of Botoșani, located at a distance of 20 km.

3. Results

The data taken from the Botoșani weather station indicate that cumulonimbus clouds (60-80%), often anvil-shaped, stagnated from 11 PM on the 10th of July 2014 to 7 PM on the 11th of July 2014 at an altitude of 600-1000 m. (Source: http://www.rp5.ru). A video recording of the Hănești meteorological phenomenon (Fig. 1) presents an anticyclonic tornado with a visible funnel in contact with the ground as well as the tornado cloud.

As can be seen in the map created following field research (Fig. 2), the tornado was formed in an open field outside the commune, towards Brăteni, going between points P1 and P3 on a distance of 4.5 km, and then moved from East to West inside the commune of Hănești between points P3 and P6 on a distance of 2 km. The tornado's diameter increases to circa 150 m in the center of the commune causing the greatest damage, and finally it moves on the surface of the Hănești Lake, becoming a waterspout (by raising water) and decreasing in intensity towards the commune of Miron Costin. From the locals' accounts, one person, namely Ilie Tomniuc, was carried by the wind circa 100 m, and as the vortex moved, a noise similar to that of an airplane in flight could be heard.

The Hănești meteorological phenomenon was associated with electrical discharge and torrential rain over a period of 20 min which fragmented the asphalt road (Fig. 3). The quantity of rainfall registered by the Botoșani weather station was on the 11th of July 2014 was 79.8 mm, equal to the average of one entire summer month.

Figure 1 Tornado cloud, 11th of July 2014, Hăneşti (Botoşani). Source: Romanian Meteorological Society Bulletin, No. 3, September 2014, pg. 30.

Following the processing of data from the inventory sheet of damaged households in the commune of Hănești as a result of the meteorological phenomenon on the 11th of July 2014 between 12:58 PM and 13:00 PM, approved by the Botoșani County Prefecture (Table 1), there are records of damage in 73 households (out of 328 total) including 65 houses and 53 outbuildings. The total surface of damaged roofs is 2,824 m^2, the most affected being those made of asbestos (78), and the least affected being those made of tin. Also added to the count are the walls of two buildings, made of brick and concrete, and the windows of three buildings, of which two made of glass and one of plastic.

In Romania, an analysis of damage caused by a tornado in order to determine maximum wind speed is difficult to perform since not all American damage indicators can be correlated, there being differences in architectural styles and building materials. For this evaluation, we have only used 6 indicators out of a total 28.

3.1. Damage Indicator 1: Small barns, farm outbuildings (SBO)

The tornado affected over 53 outbuildings covering over 1200 m^2 altogether, and numerous chimneys have been destroyed. The walls of a property in construction made of concrete reinforced with steel were destroyed entirely (Iordache family) (Fig. 4) and the roofs of two outbuildings were lifted (families Ailoaei and Zahariuc). The age and low quality of adobe buildings lead us to choose the lower threshold of visible damage, meaning the minimum wind speed for this type of destruction, which is 130 km/h.

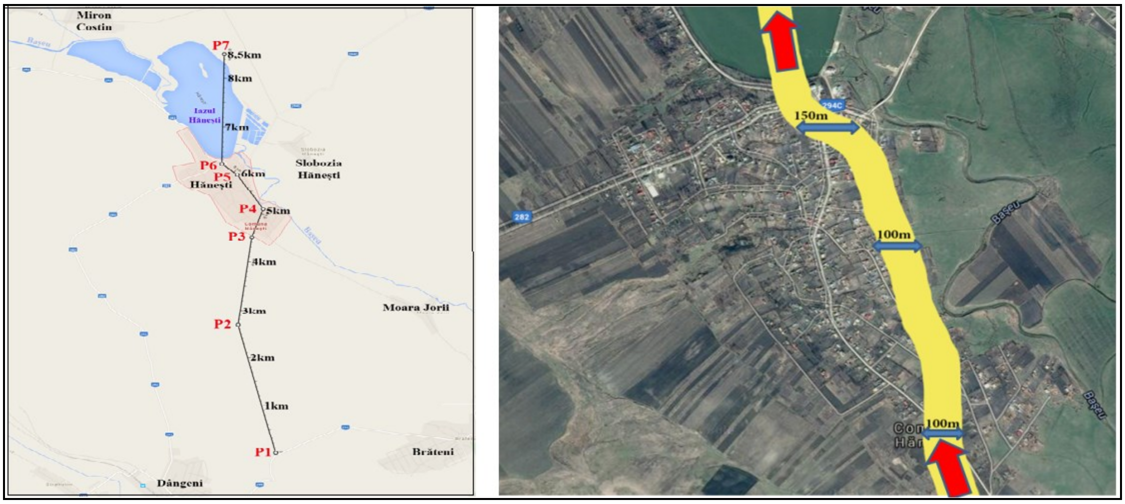

Figure 2 The path of the tornado on the 11th of July 2014 on the territory of the commune of Hănești, Botoșani County. Source: http://www.google.ro/maps, processed in Adobe Photoshop.

Figure 3 11th of July 2014, 2:30 PM. The storm created by the tornado flooded the interiors of households (left) and fragmented the asphalt road (right).

Table 1 Inventory sheet of damaged households in the commune of Hănești as a result of the meteorological phenomenon on the 11th of July 2014. Source: Hănești Commune Hall.

Nr.crt.	Construction material			Roof material			Framing	Windows	
	Adobe	Brick	Concrete	Tiles	Asbestos	Tin	Lumber	Glass	Plastic
Buildings damaged	64	8	1	15	78	15	17	2	1
Damage in m²				298.0	1,760.0	766.0	17.0	20	10
Value (RON)	1,160		1,500	17,200	67,335	17,568	9,420	376	3,000
Insurances	18								
Total affected families = 73				Total value of damage = 117,559 RON					

Figure 4 Concrete outbuilding with destroyed walls (left), and outbuilding with roof lifted by wind and carried 50 m (right).

3.2. Damage Indicator 2: One- or two-family residences (FR 12)

65 roofs were affected, with a total damaged area of 1,607 m². The roofs of 44 buildings were damaged in proportion of over 20%, indicating wind speeds between 130-186 km/h. The presence of a tornado can also be assumed from the upwards separation of tin roofs (Fig. 5).

The roof of one particular house was carried by the wind over a distance of more than 150 m, and fragments of a roof were stuck by the wind to the top of a transmission line tower. We consider that the structure of the adobe houses does not conform to American construction norms since the roof is not firmly attached to the building's walls. As such, we once again took the minimum damage threshold, with a wind speed of 167 km/h.

Figure 5 Building with roof separated and carried 150 m (left), and another building with a tin roof separated upwards (right).

3.3. Damage Indicator 24: Transmission line tower (TLT)

Certain towers had their wire supports removed, and even some metal bars were broken (Fig. 6). We considered the minimum visible damage threshold, with a wind speed 185 km/h.

3.4. Damage Indicator 26. Free standing pole (light, flag, luminary) (FSP)

The wind had bent the support poles of signs to the ground (Fig. 7). Since the metallic support poles were small in diameter, we established the minimum damage threshold, with a minimum speed of 137 km/h.

Figure 6 Broken steel bar (left), and a roof carried by the wind over a distance of circa 150 m (right).

Figure 7 Metallic panels (left) and signs (right) bent to the ground.

3.5. Damage Indicator 27: Hardwood trees (TH) and 28: Softwood trees (TS)

In the commune's center, multiple hardwood trees (acacia) with trunks measuring 30 - 40 cm in diameter were broken at approximately 1.0 - 1.5 m above ground level, indicating wind speeds between 150 - 215 km/h, and we chose to associate the maximum speed of 215 km/h, equivalent to grade IV of tree destruction. With numerous hardwood trees in the area being uprooted and contorted (Fig. 8), we associated the maximum value of this damage indicator, 118 mph or 190 km/h.

We consider these indicators to be appropriate and not in need of any adapting, since in the USA as well as Romania the same species of trees, both hardwood and softwood, can be found, and as such the necessary wind speed to cause this degree of destruction should not differ significantly between the two.

Figure 8 Contorted tree (far left). Uprooted walnut tree (center left). Broken chestnut trees, with diameters of 30 - 40 cm (center right). Broken softwood trees with diameters of 30 - 40 cm (fir, spruce) (far right).

4. Conclusions

The tornado's intensity is individually determined for each damage indicator, and lastly the tornado is associated with the maximum value of all indicators. The last two indicators (27 and 28) clearly show that the wind had reached speeds of 128 - 134 mph, equivalent to 206 - 215 km/h. Therefore, we classify this tornado as an EF2, with wind speeds between 178 - 217 km/h, or 111 - 135 mph.

In evaluating the Hănești tornado, the following problems were identified:

- Buildings with the same purpose in the USA as well as Romania are built in dissimilar ways regarding structural resistance.
- During field research, some locals' accounts were exaggerated.
- There is no direct correspondence between the damage indicators of the Enhanced Fujita scale and the Romanian inventory sheet of damaged households and outbuildings, which includes only damaged buildings, roofs, and windows.
- Our belief is that the intensity of these phenomena will continue to increase in time due to climate change.

References

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Botoșani weather station data (http://www.rp5.ru).

Photographs belonging to the Hănești Commune Hall, Voluntary Service for Emergency Situations.

Video recording belonging to Lucian Manole, from Hănești.