

# The vulnerability of the European Road 85 to blizzard, on the road section between Urziceni and Buzău

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## Abstract

The blizzard phenomenon is the climate risk that has the greatest impact on the road-ways in the South-Eastern part of Romania. The E85 section between Urziceni and Buzău has a great vulnerability to blizzard. Its vulnerability was proved during the 26<sup>th</sup> of January – the 14<sup>th</sup> of February 2012, when the road-way was blocked for 10 days. In order to establish the vulnerability level for E85 road, the section between Urziceni and Buzău, the Roads Vulnerability to Blizzard Index (RVBI) has been calculated and spatially modelled by using the GIS techniques. This index integrates several factors, such as: road sections orientation, buildings density in the vicinity of the road, width of the villages that are crossed by E85, the snow drift potential, within built-up area's orientation to E85, the negative relief forms along the road section. The calculation of the RVBI points out that 74% of total length of the road present high and very high vulnerability during blizzard phenomenon. The road sections with high and very high vulnerability need protective measures, such as: forest belts plantation, using bigger snow fences, increasing the snow fences density and achieving more equipment for snow moving off by the local authorities.

**Keywords:** *E85, Buzău, Urziceni, snow drift, road section, blizzard.*

## Rezumat. Vulnerabilitatea la viscol a Drumului European 85, pe sectorul dintre Urziceni și Buzău.

Viscolul reprezintă riscul climatic cu cel mai mare impact negativ asupra funcționalității căilor rutiere din partea de Sud-Est a României. Cu o vulnerabilitate ridicată la viscol se prezintă și sectorul Drumului E85 dintre Urziceni și Buzău, aceasta fiind confirmată în perioada 26 ianuarie – 14 februarie 2012, când artera rutieră a fost blocată pentru o perioadă de 10 zile. Pentru stabilirea gradului de vulnerabilitate a tronsoanelor componente sectorului de drum analizat, s-a calculat și spațializat în mediul GIS Indicele Vulnerabilității Căilor Rutiere la Viscol (IVCRV) care integrează factori precum: orientarea tronsoanelor de drum, densitatea caselor din vecinătatea drumului, lățimea satelor traversate de E85, potențialul la troienire a zăpezii, orientarea zonelor construite traversate de E85 față de acesta și prezența formelor negative de relief în lungul sectorului de drum. Calculul IVCRV evidențiază prezența pe 74% din lungimea tronsoanelor analizate a unei vulnerabilități ridicate și foarte ridicate la fenomenul de viscol. Aceste porțiuni de drum necesită adoptarea unor măsuri de protecție precum: plantarea unor perdele forestiere, îndesirea și creșterea dimensiunilor parazăpezilor și dotarea autorităților locale cu un număr mai mare de utilaje de deszăpezire.

**Cuvinte-cheie:** *E85, Urziceni, Buzău, troienire, sector de drum, viscol*

## Introduction

In Romania, blizzards were studied by Vancea, N. (1956), Bălescu and Beșleagă (1962), Drăghici (1986), Ciovica and Beșleagă (1973), Bordei – Ion Ecaterina and Bordei – Ion Nicolae (1983), Ciulache and Ionac (1995), Cordoneanu and colab. (1997), Bojan Dorina (2008), Meda Georgescu (2010), Costache R. (2012) and others.

Blizzard is a typical climate risk phenomenon of the South-Eastern part of Romania, which occurs during the second half of November and the first half of March (Ciulache & Ionac, 1995). This phenomenon occurs in the study area as a result of the atmospheric coupling between the Siberian Anticyclone and a Mediterranean depression (Bordei-Ion Ecaterina, 1983). The blizzard phenomenon is marked by abundant snowfall and high wind speeds, of over 20 km/h, which generate the snow storm and the intense snow drift (Bordei-Ion N, 1988).

Snow sweeping off, intense snow drift and severe visibility decrease cause major trouble on the roads, by blocking them and also cause important human and economic loss (Cordoneanu E., Drăghici I., 2011).

The present study was made due to the high vulnerability to blizzard phenomenon of the roads in the Bărăgan and Buzău plain area, where the most important road is found: the European Road 85 (DN2).

The practical utility of this study results from the necessity of identifying the vulnerable parts of the roads, in order to take protective measures. This necessity was proved at the beginning of year 2012, during 3 weeks of severe blizzard phenomenon (25 January – 14 February), when the area between Urziceni and Buzău was closed for 10 days, according to the National Highways Company and the National Roads Company.

According to the Romanian Transporters Union, the closure of the Southern and South-Eastern roads

in the country, during 25 January – 14 February, caused severe economic loss of over 3 million euro per day, which induced the national GDP decrease on average term.

Theoretically speaking, this study is very useful due to the lack of special Romanian literature in this domain and the lack of writings regarding the roads vulnerability to blizzard.

### Study area

The road section between Urziceni and Buzău, belonging to the European Road 85, has 51.7 km length and it is located in the South-Eastern part of the country (Fig. 1), in the plain of Bărăgan and Buzău, and it is also included in the Ialomița Plain (in the South-Western part of Buzău city). This road goes through 8 localities, without counting the extremities, Urziceni and Buzău city.

Due to its geographical position, this road is directly influenced by the North-Eastern continental atmospheric air which generates severe winter phenomena and gives the road a high vulnerability to blizzard.

The wind direction during snow storms, recorded at Buzău and Urziceni meteorological station, is North-Eastern (Clima României, 2008). The high frequency of snow storms in this part of the country, between 5-7 days per year (Beșleagă N., 1962), is caused by the air sewerage (Fig. 2) between the Curvature Carpathians and Măcin Mountains (Lungu M, 2008).

The highest number of days with snow storms occurs in January (Georgescu Meda, 2010), which means 28% of the cases at Buzău meteorological station. At the same meteorological station, the frequency of the days with snow storms was 5.5 days per year, during 1990-2012 ([www.tutiempo.es](http://www.tutiempo.es)) (Fig. 3). During snow storms, snow drifts can reach 4 m height (Bogdan O., 1978). Sometimes, the wind speed can reach 120 km/h, as it happened in February 1954, during the 'Great Snow Storm' (Clima României, 2008).

## Data and methods

In order to reach the main objective of this study, which is to establish the E85 road sections vulnerability to blizzard, the Roads Vulnerability to Blizzard Index was considered (RVBI).

The methodology is personal and there are no studies in the special literature regarding this issue. The method consists in the RVBI determination, by integrating several factors that are characterized by spatial distribution and that influence the snow storm process and the snow drift level during blizzard phenomenon. These factors are: the road sections orientation to the North-Eastern wind direction during the blizzard phenomenon; the buildings density in the

villages that are crossed by the E85 and that are generally located in the Eastern part of the road, directly exposed to the wind direction; the width of the Eastern parts of the villages that are crossed by the E85; the roads sections snow drift potential; the buildings orientation to the E85; the presence of the relief negative forms that are crossed by the E85 (valleys, drains, loess microdepressions) The integration of these factors was made by using the GIS techniques, by totalizing the particular vulnerability values of each road section according to the factors. In order to apply this method of work, there were made a series of operations which can be divided in 4 parties:

I. Achieving geographical data form 1:5000 orthophotoplans (ANCPI, 2008).

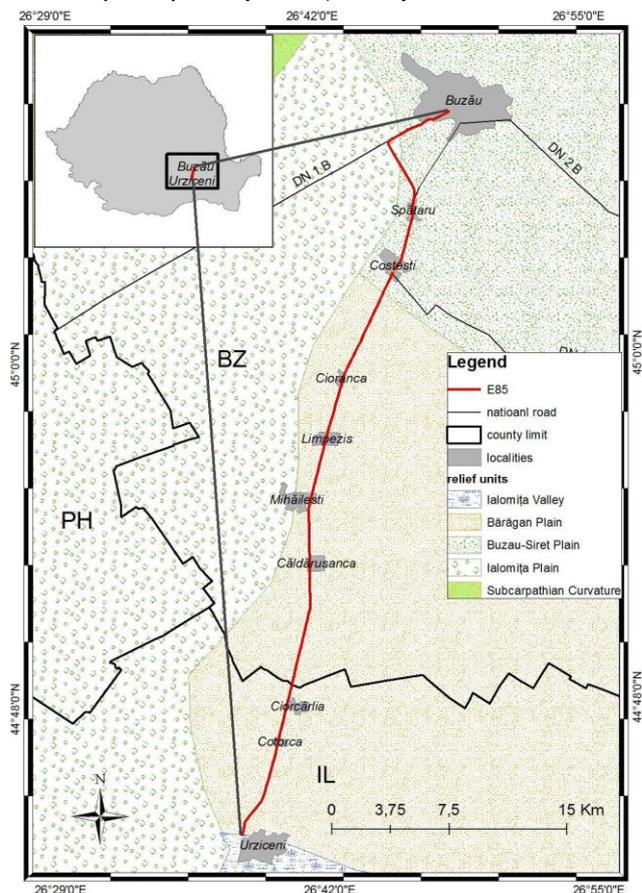
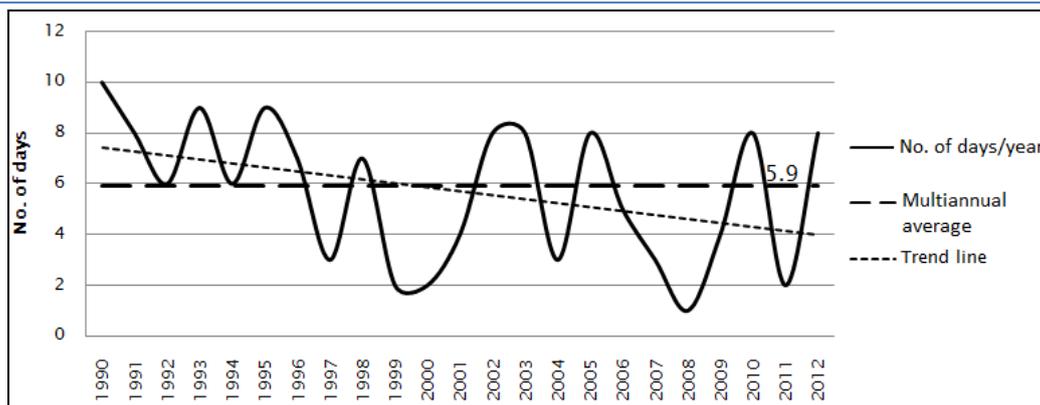


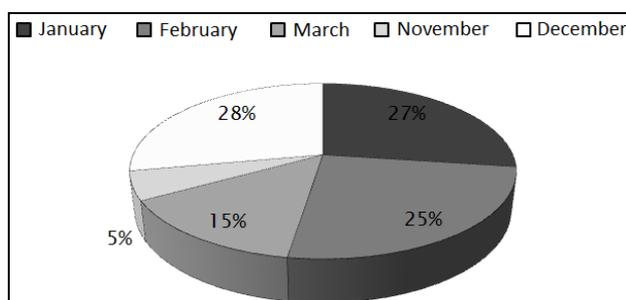
Fig. 1: The location of E85 section between Urziceni and Buzău in Romania

In this step, 25 road sections of E85 were drawn; all the right sided buildings of the E85, according to the road direction towards Buzău city, were drawn by using point marks, in order to establish their density as a factor that influences the snow storm and the snow drift process. The areas where the villages that are crossed by E85 are found were also drawn by using polygon marks, in order to measure the right sided (Eastern) parts width, according to the road direction towards Buzău city.



**Fig. 2: The evolution of the number of days with blizzard at Buzău station (1990-2012)**

(Source: [www.tutiempo.es](http://www.tutiempo.es))



**Fig. 3: The weight average monthly number of days with blizzard at Buzău station (1990-2012)** (Source: [www.tutiempo.es](http://www.tutiempo.es))

The road sections which cross negative relief forms were identified by using a ground digital model which was created after drawing contour lines and altitude points from 1:5000 topographical plans.

**II.** Identifying the main characteristics of each road section of E85 between Buzău and Urziceni.

For each road section, the orientation was established by starting from 0° which represents the North direction. In order to establish the orientation, the extremities of the road sections which are oriented towards Buzău city were considered. Regarding the villages which are crossed by E85 and located on its right side, towards Buzău city, the buildings density was determined and values between 3-7 inhabitants/ha were obtained. The right-sided parts of the villages, as E85 crosses them towards Buzău city, were measured and values between 150-1340 m were obtained. Afterwards, the snow drift potential was established, using a scoring between 1 - 5 points, according to the land use in the vicinity of the road sections and to the within the built-up area width. The within the built-up area orientation to the right side of the road sections was also considered in order to establish the level of vulnerability.

**III.** Giving a vulnerability score to each road section, in the attribute table of the vector represented by the road section between Urziceni

and Buzău, according to its characteristics, marked in different columns.

The vulnerability values were given by personal field observation on the way that the specific factors influence the snow storm and snow drift process during blizzard phenomenon.

Values of 1 and 2 points of vulnerability were given to those factors that cause the decrease of a road section vulnerability to blizzard, while values of 4 and 5 points of vulnerability were given for those factors that cause the increase of the vulnerability. Regarding the road sections orientation, the longitudinal road sections, according to the Crivetz direction (NE-SV), were given 1 point of vulnerability to blizzard, because these road sections are less exposed to snow drift, while the transversal road sections (NV-SE), were given 5 points of vulnerability because these are the most exposed to snow drift road sections.

The high density of the houses in the villages that are crossed by E85 causes a snow drift reduction, while the lack of buildings causes an intense snow drift on the road-way.

The large width of the villages on the exposed to Crivetz side causes the decrease of snow quantity on the E85 road-way.

The factor that has the greatest snow drift potential is the presence of negative relief forms that cross E85, between Urziceni and Buzău. Frequently, 'snow dumplings' are found here.

**IV.** Totalizing the factors, using ArcGIS 9.3, by totalizing the columns in the attribute table, which contained the vulnerability score for each characteristic road section.

In this way, the RVBI values were obtained and classified according to the extreme values in five classes, such as: (i) very low – RVBI < 8 – for the less exposed to blizzard road sections; (ii) low – 8 < RVBI < 10; (iii) - medium – 10 < RVBI < 12; (iv) high - 12 < RVBI < 14; (v) very high – RVBI > 14 – for the most exposed to blizzard road sections (Table 1).

**Table 1 Clasification and indexing of necessary factors for the RVBI values composition on the E85 road section between Urziceni and Buzău**

<i>Roads orientation(°)</i>	<i>Buildings density near E85 (houses/ha)</i>	<i>The width of the villages crossed by E85 (m)</i>	<i>Snow drift potential</i>	<i>within the built-up area orientation to the E85</i>	<i>Negative relief forms on the E85 road sections</i>	<i>Score given</i>	<i>RVBI value</i>
33-57° (N-E- SV)	-	1080-1340	-	N-S	-	1	Very low < 8
22-23° (N-NE – S-SV)	6-7	560-872	Road section that crosses villages of over 1 km width	N-NE – S-SV	-	2	Low 8-10
8-15° (N-NE – S-SV)	-	300-330	Road section that crosses villages of 560-872 m width	NE-SV	-	3	Medium 10-12
358 – 0° (N-S)	3	150	Road section that crosses villages of 300-330 m width	-	-	4	High 12-14
330° (NV-SE)	0	0	Road section that crosses villages of 150 m width	Road sections on open field	valleys, drains,loess microdepressions	5	Very high >14

## Results and discussions

By using this methodology, RVBI values between 6 and 16 were obtained for the E85 road section between Urziceni and Buzău. The values were ordered in five classes (Fig. 4).

The highest RVBI values (>14), correspond to the road sections that cross negative relief forms, where the snow drift potential is very high and causes snow dumpings even during less intense snow storms and road-way blocking. On the road section between Urziceni and Buzău, there are three negative relief forms: the first one is of 150 m length and 3 m depth (source: Topographic Plan, 1:5000) and it is found in the vicinity of Cotorca (Fig. 4); the second one is of 100 m length and 5 m depth (source: Topographic Plan, 1:5000) and it is found at 800 m distance from the first one, towards Buzău city, corresponding to a tributary of the Cotorca river; the third one is of 130 m length and 3 m depth (source: Topographic Plan, 1:5000), near Mihăilești (Fig. 4).

There are also other two lowland road sections which correspond to the fifth class of values. The first section is characterized by a length of 6.4 km and a N-S orientation and it is found at 15 km near Urziceni. The section is interrupted by 1 km of road belonging to Căldărușanca village, which is protected from snow storm by the buildings. The second road section has a length of 3.43 km and a NV-SE orientation (perpendicular to the wind direction during blizzard) and it is found between Spătaru extremity and E85 intersection with DN 1B road (which connects Buzău to Ploiești city).

The high vulnerability of these road sections is caused by their position in the open field and by their orientation to a trajectory that is near by the

perpendicular trajectory to the main Crivetz's direction (NE-SV). This factor supports an active snow transport from the adjacent field to the E85 road-way. The road sections between Urziceni and Buzău, for E85, with high vulnerability to blizzard represent 18% (Fig. 4) of the total length and have a cumulated length of 9.3 km. The road sections with high vulnerability to blizzard represent 56% of the entire section between Urziceni and Buzău and have a cumulated length of 29.5 km (Fig. 4). These sections are generally found on the open field areas with N-NE – S-SW orientation, and also on the road sections belonging to Mihăilești and Cioranca localities, where the within –built-up area low width on the right side of E85 and the buildings low density cause a weak protection against blizzard phenomenon. In the case of Mihăilești, the high vulnerability of the road section that crosses the locality has been proved during 25-26 January 2012, when 40 trains and 80 cars were blocked, creating a 3 km column of cars (ISU Buzău, 2012).

Protective measures against snow drift must be considered in the case of E85 section between Urziceni and Buzău, where road sections with high vulnerability to blizzard are found. These measures suppose: planting protective forest belts on the road intersection with DN 1B road (which connects Buzău to Ploiești city).

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Protective measures against snow drift must be considered in the case of E85 section between Urziceni and Buzău, where road sections with high vulnerability to blizzard are found. These measures suppose: planting protective forest belts on the road edge that is exposed to the wind direction, properly

placing the snow fences and placing bigger and even more snow fences (in Romania, there is 1 km\*snow fences/100 km, CNADNR, 2012).

E85 road sections between Urziceni and Buzău that correspond to RVBI values between 10 and 12 (the third class of values, with medium vulnerability to blizzard) are characterized by their position out of the villages and their orientation close to the main wind direction during blizzard phenomenon. This class of values means 14% of the total length of the road and a cumulated length of 7.23 km.

Low and very low values of vulnerability to blizzard correspond to the road sections of E85 that cross the villages, except Mihăilești and Cioranca localities. The lower vulnerability is given by the high density of the buildings and by the high width of the right side of the villages. Due to these factors, a high quantity of snow is stored and prevented from reaching the road-way. Road sections with low and very low vulnerability to blizzard represent 12% of the total length and have a cumulated length of 6.15 km.

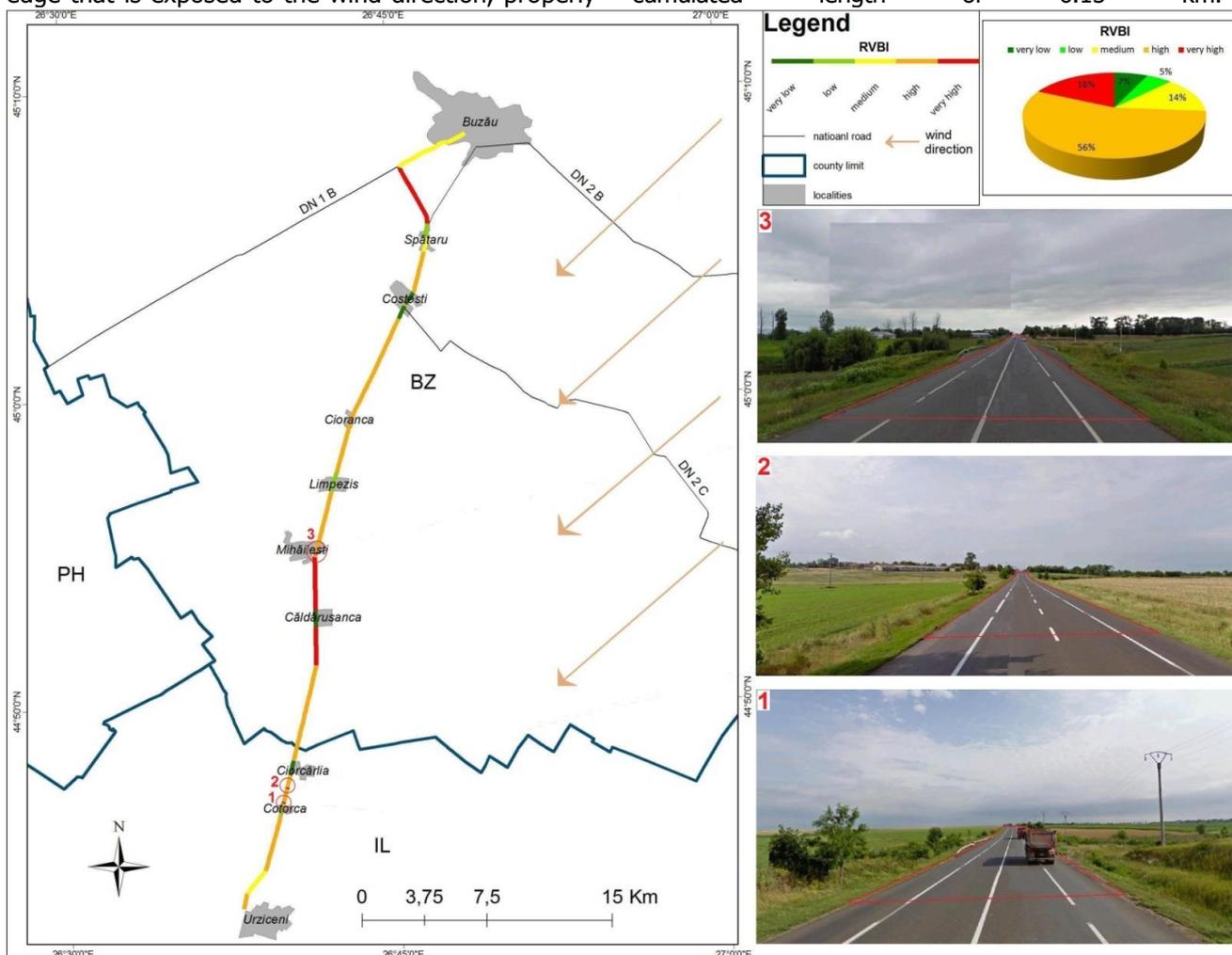


Fig. 4: RVBI distribution along the European Road 85 between Urziceni and Buzău

## Conclusions

The E85 road section between Urziceni and Buzău is one of the most vulnerable roads to blizzard phenomenon in Romania, due to its geographical position. Its area is influenced by the North-Eastern air that comes from the Russian Plain, especially during winter.

The RVBI spatial distribution along the E85 road section between Urziceni and Buzău clearly points out the vulnerable to blizzard road sections and also points out their value of vulnerability.

In order to obtain the RVBI values, the main factors that influence the snow storm and snow drift process have been considered. These factors are: the roads orientation ( $^{\circ}$ ) to the main Crivetz direction, the density of the buildings in the villages, the width of the right parts of the villages that are crossed by the E85 (towards Buzău direction), the snow drift potential according to the land use in the vicinity of the road sections, the within built-up area orientation to the E85, the negative relief forms.

Regarding the RVBI values distribution, the remarkable weight of the values of 4 and 5 points of vulnerability highlights high and very high vulnerability to blizzard. The values of 4 and 5 points of vulnerability totalize 74% of the total length of the E85 road section between Urziceni and Buzău and correspond to open field road sections and to road sections with close orientation to the Crivetz North-Eastern perpendicular.

In the case of the road sections that correspond to the values of 4 and 5 points of vulnerability, important protective measures should be taken against the snow transport and against the snow drift on the road-way.

The protective measures are: planting protective forest belts on the road edge that is exposed to the wind direction, properly placing the snow fences, placing bigger snow fences and increasing the snow fences density.

The other classes of values correspond to road sections with medium, low and very low vulnerability to blizzard. But these three classes of values totalize only 26% of the total length of the road.

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