ROADS EXPOSURE TO BLIZZARD PHENOMENON
IN THE PLAIN ZONE OF BUZĂU COUNTY

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Contents:

1. INTRODUCTION ................................................................. 181
2. METHODOLOGY .............................................................. 182
3. STUDY AREA ................................................................. 185
4. RESULTS AND DISCUSSION ........................................... 189
5. SOLUTIONS ................................................................. 192
6. CONCLUSIONS ............................................................... 192
7. REFERENCES ................................................................. 193

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Roads exposure to blizzard phenomenon in the plain area of Buzău County

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L'exposition à la tempête de neige des routes dans les plaines de Buzău. Les plaines de Buzău représentent une des plus vulnérables zones au phénomène de la tempête de neige. Cette phénomène produit le plus grand dommage en ce qui concerne la fonctionnement des routes, causant souvent leur bloc. Les plus vulnérables routes dans cette zone, en fonction de leur importance économique, sont les routes reliant les villes de Buzău, Râmnicu Sărat et Pogoanele avec les résidences du comté voisin, et la route européen 85 avec la région du Moldavie. La carte de la vulnérabilité des routes dans les plaines de Buzău montre que les routes plus exposé sont E85 et DN 22 (entre Râmnicu Sărat et Brăila).

Mots-clés: tempête de neige, vulnérabilité, routes, plaines de Buzău.

Expunerea la viscol a căilor rutiere din zona de câmpie a județului Buzău.
Zona de câmpie a județului Buzău este una dintre cele mai vulnerabile areale la fenomenul de viscol. Acest fenomen produce cele mai mari pagube în ceea ce privește funcționalitatea căilor de comunicație rutiere, generând deseori blocarea acestora. Cele mai vulnerabile drumuri din această zonă, prin prisma importanței lor economice, sunt drumurile naționale ce leagă orașele Buzău, Râmnicu Sărat și Pogoanele de reședințele județelor vecine, și drumul European 85 care leagă Bucureștiului de Moldova. Pe „Harta vulnerabilității căilor rutiere din zona de câmpie a județului Buzău” se observă că cele mai expuse artere rutiere sunt E85, și DN 22 (Rm. Sărat - Brăila).

Cuvinte cheie: viscol, vulnerabilitate, drumuri, zona de câmpie a județului Buzău.
1. INTRODUCTION

Blizzard is a typical climate risk phenomenon of the South-East region of Romania, which occurs in the second half of November [1]. This phenomenon occurs in the plain area of the county of Buzău as a result of an atmospheric coupling between the Eastern European anticyclone and the Mediterranean depression which is centered in the southern part of the Balkanic peninsulas (Figure 1) [2].

![Typical synoptic situation producing blizzards in SE Romania](http://www.wetter3.de/Archiv/archiv_ukmet.htm)

**Figure 1.** Typical synoptic situation producing blizzards in SE Romania

Source: http://www.wetter3.de/Archiv/archiv_ukmet.htm

Generally speaking, the blizzard phenomenon occurs when snow fall is associated with a wind speed exceeding 20 km/h [1]. It can also occur in the absence of the snow fall, in the case of snow cover preexistence, when snow cover is winnowed by strong wind, this specific phenomenon being called ‘ground blizzard’ [3].

The strongest of these hazards are associated with wind speeds that exceed 120 km/h [4]. The great blizzard in February 1954 has marked the history of Romania weather, when snow banks reached several meters in the Southern and South-Eastern part of Romania [5].
The most affected social and economic objectives by the producing of such a climate risk are the roads and the biggest problems are caused by heavy snow in the near field. These problems are generally related to heavy snow falls on road vehicles and the economic loss which is caused by the long-term closures of the roads. Such a severe weather episode occurred in the late January and in the early February, when three blizzard episodes caused a long-term closure of the roads, generating economic losses among the transporters and the national GDP on the long-term [6].

2. METHODOLOGY

In order to assess the roads vulnerability in the plane zone of Buzău county, I used a proper methodology. This methodology was never used before, because there is no existing study regarding the roads exposure to the blizzard phenomenon using the same vulnerability factors.

In this study, the GIS techniques which are embedded in ArcGIS 9.3 and Global Mapper 12 software were used. Firstly, due to these programs, the study area was delimited and after that, the road network was identified by using the criteria of county, national and european roads [7].

The length of the roads was calculated for each category of road, in order to to set the overall roads density in the plains of Buzău County.

The roads vulnerability factors were established by giving each of them vulnerability scores in order to obtain the roads vulnerability in the plains of Buzău County final map. These factors are mainly related to the geographical location of the roads within the study area, to the roads orientation depending on the dominant direction of the Crivet, to the roads economic importance in the study area and to the snow-drift potential in the study area.

Related to the geographical position, the roads in the south-western area study were awarded 1 point of vulnerability (Figure 2), meanwhile the roads in Râmnicu Sărat City area were awarded up to 3 points of vulnerability, because here wind is more intense and the blizzard phenomenon occurs more frequently.

Regarding the roads orientation to the Crivet, longitudinal wind direction roads (NE-SW) were awarded 1 point of vulnerability (low), meanwhile perpendicular oriented roads (SE-NW) were awarded 3 points of vulnerability (high) (Figure 3).
Figure 2. Road vulnerability to blizzard from the geographical perspective
(Data source: http://www.openstreetmap.org/)

Figure 3. Roads vulnerability to the blizzard depending on the Crivetz main direction
(Data source: http://www.openstreetmap.org/)
Regarding the economic importance of the study area roads (Figure 4), 1 point of vulnerability (low) was awarded for remote county roads that do not necessarily connect to a major urban center or other highway, and 4 points of vulnerability (high) were awarded to E85 which is the most important analyzed artery crossing the area.

Finally, the snow-drift potential for the study area was included (Figure 5). The snow-drift potential was obtained by integrating factors such as land use, slope aspect and negative landforms. The village buildings which are located in negative landforms represent the most exposed to blizzard areas. Corine Land Cover 2006 data source was used in order to obtain the land use information and the SRTM data (obtained from Geospatial site) [8] was used in order to determine the slope aspect and the negative landforms.
By integrating the four mentioned factors, we obtained the roads vulnerability to blizzard in the plains of Buzău county final map (Figure 14).

3. STUDY AREA

The Plain of Buzau County is situated in the South-East of Romania (Figure 6), being under the direct advection influence of cold continental winter air masses [9].

The land configuration in the study area causes the channeling of the cold air coming from the northern Russian Plain through the corridor between the Carpathians Curvature and the Măcin Mountains (Figure 7) [10].

This channeling air corridor, on that specific gap, causes the wind power lines thickening in this part of the country (Figure 8), which leads to wind speed increase and blizzard frequency increase.
The plains of Buzău County have low relief altitudes, and a 92% prevalence of flat surfaces in the study area (Figure 9), which cause the maintaining of high wind speeds, as a result of the low friction coefficient between the horizontal air and the land surface.
Figure 8. Wind power lines thickening in the South-East region of Romania
(Data source: http://earth.unibuc.ro/)

Figure 9. The aspect in the plain areas of the Buzau County
(Data source: Processed Srtm data using Arc Map 9.3)
The physical and geographical characteristics of the study area had made it the most vulnerable to blizzard of all regions, beside Bărăgan and southern Moldova areas.

The average number of days with blizzard phenomenon, which was obtained by mediating values between 1990-2012 at Buzău meteorological station, is of 5.9 (Figure 10) [11].

![Figure 10. The evolution of the number of days with blizzard at Buzău station (1990-2012)](Data source: www.tutiempo.es)

This parameter shows a clear decreasing tendency during the study period, which is pointed out by the linear trend line.

The greatest weight of days with blizzards has been registered in December and January, when 28% and 27%, respectively, of all the annual average cases occur, followed by February when 25% of the phenomenon cases occur (Figure 11) [11].

![Figure 11. The weight average monthly number of days with blizzard in Buzău (1990-2012)](Data source: www.tutiempo.es)
In the study area, such as in other areas of our country, the roads are the most affected by the blizzard phenomenon. The main problem regards the snow-drift of the roads which is caused by the wind which blows the snow from the field to the road. After this process, the motors vehicles are snow-bond.

The plains of Buzău County are crossed by a number of 756 km of county, national and European roads. The most numerous are the county roads, with a length about 500 km, followed by the national and E 85, with a length of 88 km in Buzău County (Figure 12).

The highest roads density of the study area are recorded around the main urban centers (Râmnicu Sărat and Buzău). There are more than 30 km of roads length related to a surface of 100 km² (Figure 13).

4. RESULTS AND DISCUSSIONS

After the summation of the roads vulnerability factors, the roads vulnerability in the
plains of Buzău county map was finally obtained (Figure 14).

![Figure 13. Road density in the lowlands of Buzău County](http://www.openstreetmap.org/)

According to this map, roads with low vulnerability to blizzard phenomenon are represented on the map with the yellow color and share 8% of the total length of the main streets in the study area. These are the western county roads which are located at the contact area of the Buzău Plane and the Sub-Carpathians Curvature. The roads with low vulnerability are also found in the south-western part of the county, on the 102 H county road.

The roads with an average vulnerability to storm hold over 34% of the total length of the main streets of the area investigated. These include primarily county roads in the Bărăgan Plain with low economic importance, and DN 10 which is less exposed to the Crivetz.

41% of the roads have a greater vulnerability to blizzard phenomenon. These are all the national roads included in the study area and the county roads in Râmnicu Sărat town, where blizzard is more intense.
17% of the road length has a very high vulnerability to blizzard phenomenon. In terms of economic importance, the most exposed to blizzard phenomenon is the E85 road. The DN2 road has a high vulnerability to blizzard also.

According to the results, the roads vulnerability to blizzard phenomenon in the plain zone of Buzău county is high, as there is a constant risk of road bed snow-drift. For example, the most vulnerable areas have demonstrated that snow bed can frequently exceed 50 m height, whereas the economic loss (cused by the E85 road closure) can exceed several million Euro per day.

The advantage of this study’s methodology is that the main vulnerability factors, which cause the roads snow-drift, are integrated, and that the main factor, which is the economical factor, is also integrated. This methodology can be successfully used for studying
other areas vulnerable to blizzard phenomenon.

In the future, the study will regard the E 85 road, from the southern county limit to Buzău city, in order to improve the roads vulnerability to blizzard phenomenon highlighting, and in order to improve the intervention by posting snow reaks and planting forest areas, after identifying the vulnerable areas.

Preventive measures for blizzard phenomenon effects depletion are very important because these preventive measures are the best way to avoid human and economic loss.

5. SOLUTIONS REGARDING THE CONTROL ON THE NEGATIVE EFFECTS OF BLIZZARDS

These measures are divided into different kind of types:

a. Unstructural:
- drivers training on their awareness of the blizzard risks, on the proper way of acting in case of the blizzard phenomenon occurring.
- instructing the authorities in order to improve their intervention in case of disaster.
- improving the accuracy of ANM forecast.

Unstructural measures are very important because there was a great human and economic loss caused by the insufficient instruction of the authorities and drivers regarding the way one should act in case of severe blizzard phenomenon.

b. Structural:
- forest plantations around the village and on the roads edges, related to the dominant wind direction. Walnut trees are recommended.
- the enlarging and the use of more snow breaks
- the acquisition of a proper equipment by the local authorities in case of snow drifts.

Planting forests is the best way to protect the roads from snow-drifting and also to avoid soil erosion which has become a serious problem in the Bărăgan area.

6. CONCLUSIONS

As a result of the physic and geographical characteristics of the Plains of Buzau County, the most common climatic risk phenomenon that occurs in this area is blizzard. The study area has the greatest vulnerability of all the regions in Romania to blizzard phenomenon, and the roads are the most affected, regarding the social – economic objectives. In order to highlight the spatial distribution of the roads in the study area which are exposed to the phenomenon, I've created 'The roads vulnerability to blizzard phenomenon in the Buzău County plains map. According to this map, most of the roads are
of medium and high vulnerability to blizzard, meanwhile the most important road which provides the connection between Bucharest and Moldova, E 85, is of very high vulnerability.

7. REFERENCES