MORPHOGENETIC IMPORTANCE OF THE BORA TYPE WIND (19TH NOVEMBER 2004) IN THE SLOVAK HIGH TATRAS

KATARZYNA DĄBROWSKA, ELŻBIETA ROJAN**

Katarzyna Dąbrowska, Elżbieta Rojan: Morphogenetic importance of the bora type wind (19th November 2004) in The Slovak High Tatras. Geomorphologia Slovaca et Bohemica, 8, 2008, 1, 5 figs., 2 tabs., 4 refs.

In November 2004 the extremely strong wind caused significant changes in the environment of The High Tatras. The aim of this study was to determine the approximate quantity of soil and waste material displaced with root systems of uprooted trees. Due to the measurements done during the field studies it was possible to compute the mean volume of the displaced material per 100m^2 which is 0,14m^3. Approximate total volume for the whole windfall area was estimated at 17 000 000 m^3. The spatial distribution of such a changes in relief is not regular. An inclination of slope can be considered to be an important factor which has an influence on it.

Key words: windfall; uprooted tree; displacement of soil and waste material; bora type wind

1 INTRODUCTION

On 19th November 2004 geographic environment of the southern slopes of the High Tatras underwent sudden and catastrophic changes. During less than 3 hours the trees on the area of 12.600 ha were uprooted or broken (MOTYČKA 2005) (**Fig. 1**). This zone (approximately 30 km long and 2-3 km wide) stretches between the altitude of 800-900 and 1250-1300 m a. s. l. (**Fig. 2**). According to the estimations 3 mln m^3 of wood were destroyed which is 20 times as much as it was during the so-called *windstorm of the century* which took place on 6th may 1968 in the Polish Tatras. At that time during 4 hours the *halny* wind (foehn wind which occurs on the northern slopes of the Tatra Mountains) destroyed the forest on the area of 500 ha with total wood volume of 150 000. m^3 (KOTARBA 1970).

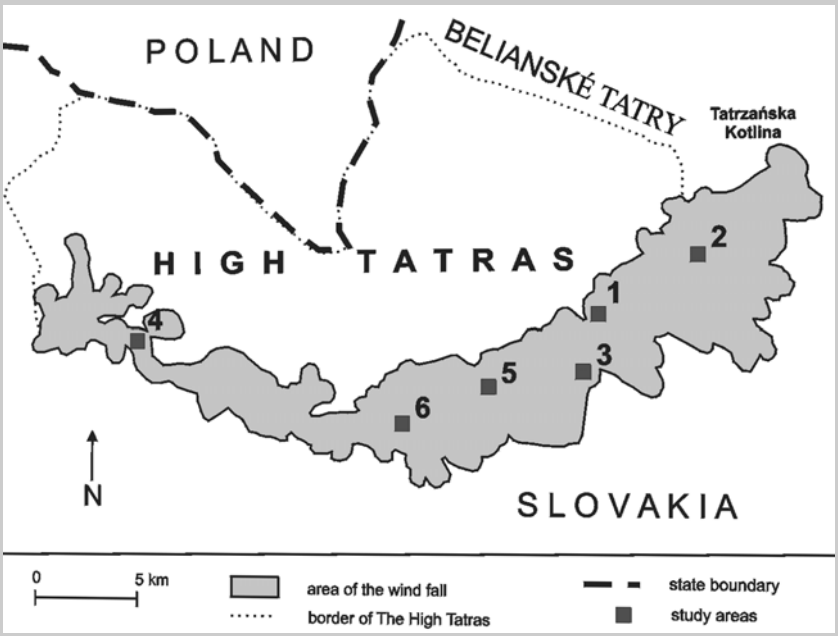

Fig. 1 The map of the study areas

*The University of Warsaw, Faculty of Geography and Regional Studies, e-mail: dabrowska85@gmail.com, erojan@uw.edu.pl

Fig. 2 Area of the wind fall: general view from Tatranská Polianka

The main reason of this ecological disaster in the Slovak Tatras was bora wind with the maximum speed reaching 230 km. h^{-1} (64 m. s^{-1}) (KOREŇ 2005). During short time many components of the natural environment (including relief) of the southern slopes of the Tatra mountain range were changed. Strong winds are capable of modeling earth surface in an indirect way. Trees, while falling, tear out some amount of soil and waste material with

Fig. 3 Uprooted trees on the study area in Dolný Smokovec

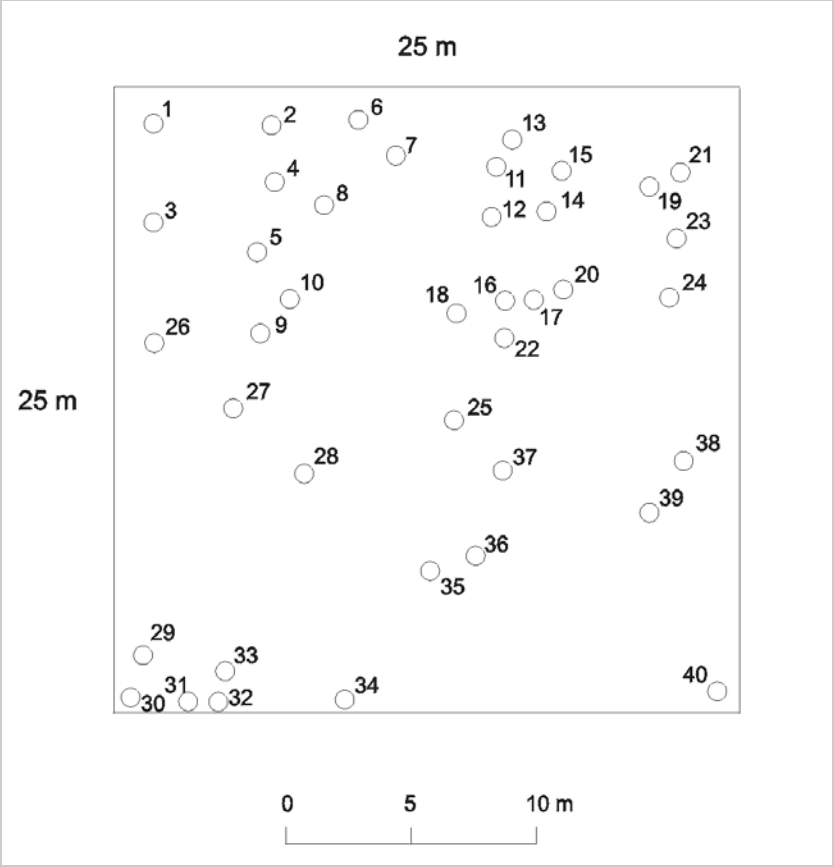

Fig. 4 Distribution of uprooted trees on the study area Tri Studničky

their root system. This material is lifted and can be displaced to a small distance (ROJAN 2007).

2 GOAL

On the area of windfall 58,6 % of the trees were uprooted and 41,4 % were broken. The main goal of the study is to present the morphogenetic role of the extremely strong wind which occurred 19th November 2004 in the Slovak Tatras by the determination of magnitude of the relief transformation.

3 METHODS

Six representative fields of study were chosen for the field work carried out in 2007. They are located on the slopes with average inclination 4-30 degrees. The area of each of them is 400 m^2 (20 x 20 m) – 625 m^2 (25 x 25 m). They are situated in the vicinity of Tri Studničky, Vyšné Hágy, Tatranská Polianka, Dolný Smokovec, Horný Smokovec and Tatranské Matliare towns (**Fig. 3**). On the study fields all the uprooted trees were measured (**Fig. 4**). The measurement included the lenght of the longer axis (a), the lenght of the shorter axis (b) and the thickness (c) of the material displaced with roots of each uprooted tree (**Fig. 5**).

4 RESULTS

Field works were carried out on the total area of 2 625 m^2 (6 study fields), on which 128 wind fallen trees were measured (**Tab. 1**). It means that on average there is 4,9 of uprooted trees per 100 m^2.

Data obtained from the field measurements were used to compute a volume of the soil and waste material displaced with a root system. Its shape was compared to a half of ellipsoid in revolution therefore we could use the formula:

$$V = 1/2 \cdot 4/3 \, \Pi \, abc$$

The mean volume of the material displaced with roots of one tree is 3,1 m^3. The total quantity of displaced material from all fields of study is 385,8 m3. These results allow to determine the mean volume of displaced material per area unit which is 0,14 m^3 per 1m^2 (**Tab. 2**).

Fig. 5 Parameters of an uprooted tree (a, b, c) measured during field works

5 CONCLUSIONS

Measurements of the uprooted trees and calculations on the data obtained from the field work allowed to determine an approximate total volume of soil and waste material displaced during the windstorm on 19th November 2004 in The Slovak Tatras which is 17 000 000 m^3. This is a few times as much as it was in The Polish Tatras in 1968, mainly because of the significant area of the windfall in The Slovak Tatras.

After the analysis of the data it was also possible to ascertain, that there is a distinct relation between the slope inclination and the

number	a	b	c	volume [m3]
1	2,5	1,5	0,9	3,5
2	2,2	1,3	1,7	5,1
3	3,5	1,5	1,6	8,7
4	2,6	1,1	1,3	3,9
5	2,6	1,5	1,0	4,0
6	2,0	0,9	1,3	2,4
7	2,2	1,5	1,4	4,8
8	2,2	0,8	1,0	1,8
9	1,3	1,0	1,0	1,4
10	2,0	0,7	0,5	0,7
11	1,6	1,5	0,6	1,5
12	2,1	0,8	0,6	1,0
13	3,0	1,5	1,6	7,5
14	1,3	1,2	0,5	0,8
15	2,5	1,6	1,3	5,4
16	1,2	0,6	0,4	0,3
17	2,7	1,1	0,9	2,8
18	1,7	1,2	1,2	2,5
19	2,1	1,4	1,6	4,9

Tab. 1 An example of data obtained from the Tri Studničky study area

study area	area [m²]	slope inclination [°]	number of uprooted trees per 100 m²	average volume [m³]	total volume [m³]	volume of displaced material [m³ m⁻¹]
Slovak Tatras 2004						
Tri Studničky (1)	625	20-30	6,4	2,83	113,4	0,18
Vyšné Hágy (2)	400	15-20	4,3	6,18	105,1	0,26
Tatranská Polianka (3)	400	30	4,8	2,28	43,4	0,11
Dolný Smokovec (4)	400	5,5	4,0	2,28	24,4	0,06
Horný Smokovec (5)	400	8	5,5	2,65	58,3	0,15
Tatranské Matlare (6)	400	4	3,5	2,94	41,2	0,10
Polish Tatras 1968						
1	625	25		2,95	74,0	0,12
2	625	25-30		3,56	67,7	0,11
3	400	25-30		1,82	56,7	0,14
4	625	30		3,37	101,4	0,16

Tab. 2 Study results from the wind falls in Slovak (2004) and Polish Tatras (1968). KOTARBA, A. (1970)

volume of the material displaced with the roots of the fallen trees. On the slopes with the inclination 15-30 degrees this quantity is much bigger then on the slopes with the inclination less then 10 degrees. Therefore the inclination of the slope can be considered to be one of the factors which influence the spatial distribution of the changes in relief caused by the bora type wind in the Tatras.

The area of the windfall in The Slovak Tatras is still being modelled by natural morphogenetic processes which lead to unfolding the roots of the fallen trees (initially covered with the material torn out from the ground while falling down) and filing the hollows from which the soil and waste material was taken with roots of fallen trees.

Microrelief, typical for the slopes with the windfall, is being stabilized by vegetation, which is gradually entering this area.

REFERENCES

KOREŇ, M. (2005). Potęga przyrody. *Tatry*, Vol. 11 (1/2005), Zakopane (Tatrzański Park Narodowy), p. 10.

KOTARBA, A. (1970). The morphogenetic role of foehn wind in the Tatra Mts., *Studia Geomorphologica Carpatho – Balcanica,* 4, Kraków, 159-169.

MOTYČKA, V. (2005). *Vietor v Tatrách. Fakty a rozhovory o Vysokých Tatrách. Aké boli, sú a budú*. Bratislava (EPOS),127 p.

ROJAN, E. (2007). „Veľká kalamita" – przyczyny i skutki huraganu w Tatrach Słowackich, *Cywilizacja i żywioły, PTGeof., IMiGW*, Warszawa, 70-77.