

PECULIARITIES OF SNOW ACCUMULATION AND AVALANCHE FORMATION IN THE TISA BASIN DURING THE 1998-1999 SNOWY WINTER

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Abstract: Based on the data of the hydrometeorological observation system, aerovisual helicopter inspections collected from organizations of motor-road facilities, forestry and control-and-rescue service, the extremely snowy winter of 1998-1999 in the Tisa (the administrative Transcarpathians region) has been revealed, during which the highest snow depth and water resources values were registered, being 2.5-3 times higher against those of many years (1947-1998) registered in lower areas (to 1000 m abs.) and 3-4 times higher against those in the Carpathians high lands (to 2000 m abs.).

It is with the significant snow accumulation that mass avalanche release was connected, sometimes these were characterized as the extreme ones whose run out distance was over 3 km and snow deposits volume- over 2000000 m³, resulting in people death, cutting off motor roads and railways, and forest destruction.

Keywords: snow cover, avalanche.

SCHNEEDECKE UND LAWINENERSCHEINUNGEN IM TRANSKARPATENGEBIET WÄHREND DER SCHNEEREICHEN WINTER

Zusammenfassung: Wie aus Angaben der hydrometeorologischen Beobachtungen, Luftsichtaufnahmen und Mitteilungen von Autotrafen -, Forstwirtschafts - und Bergrettungsdiensten folgt, der Winter 1998-1999 war im Einzugsgebiet von der Theiß äußerst schneereich. Die größte Schneehöhen und Schneewasserwerte haben die mittlere mehrjährigen Werte (1947-1998) 2.5-3 mal im Niedergebirge (bis 1000 m) und 3-4 mal in Hochgebirge überstiegen.

Diese Ereignisse haben bedeutende Schneeverammlung und extreme Lawinenerscheinungen hervorrufen. Die letzte hatten Laufweiten bis 3 km und Umfänge über 2 Mio m³. Die Lawinenerscheinungen haben in die Menschenverluste gestürzt, einige Autostraßen und Eisenbahnlinien waren dadurch gestört.

Schluesseiworte: Schnéedeske, Lawine

The object is to reveal the features of snow accumulation and avalanche formation in the winter 1998/99 which is regarded as the most extreme snowy within the observation period since 1947 (Transcarpathian joined Ukraine in 1945, that is why the information of the precedent period when the region was a part of Czechoslovakia and Hungary is not available excepting of the winter 1940/41) (Vancho I., 1963).

The observations of snow cover which were made at meteorological grounds of stations and posts, the observation data of snow cover consist of one in five- and ten-day periods on line routes and on mountain basins, the snow observations at the avalanche stations (AS) Plai (1330 m. abs.) and Pozhezhevskaya (1440 m abs.); in spite of its position a little lower than Chernogorskiy watershed mountain range in the Prut basin, it characterizes the avalanche activity on the upper Tisa); special avalanche surveys carried out by the Ukrainian Hydrometeorological Research Institute (UHRI) avalanche team and the Complex (former Kiev) hydrographic team; observation from air including snow-measuring works; data supplied by the

departments of forestry and transport , control-and-rescue service and local residents made up the database of the work (Fig.1 demonstrates the scheme of meteorological stations and posts within the Tisa basin).

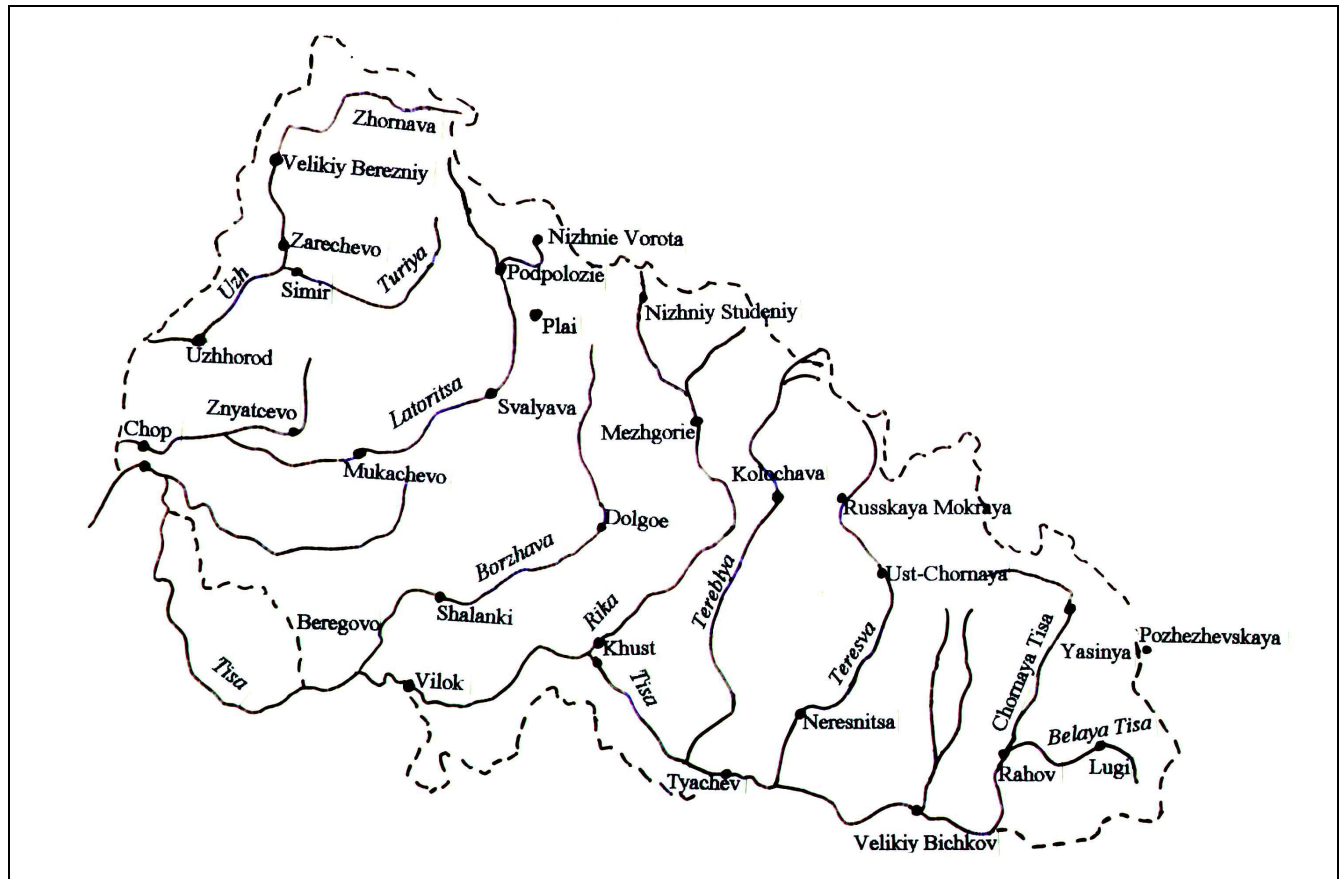


Fig. 1 The scheme of meteorological stations and posts within the Tisa basin

Data analysis of the regional hydrometeorological network related to weather and snowfall rates as well as distribution of snow accumulation over the Tisa basin allows clearing following points:

During the cold period a lot of precipitation fell out in Transcarpathie region. The total precipitation was between 300 to 500 mm on the lower plain (below 200 m abs.) where the solid precipitation was 60% of the annual total and it increased up to 700 mm on the highlands (at the AS Plai and Pozhezhevskaya and snow was 76% and 90% of precipitation respectively). Besides, there were 53.5 mm of snow in October, 33.4 mm in March, 73.4 mm in April at the Plai AS and 178.8 mm in October, 53.0 mm in March, 48.1 mm in April at the Pozhezhevskaya AS.

Figure 2 illustrates the variations of snow depth at three snow stations during the winter 1998-1999. It is based on the snow depth observations made at the meteorological stations and posts located from top to down in upper the Tisa tributary's basins. These stations are Pozhezhevskaya AS, the post Yasinya (650 m a. s. l.), and the control-and-rescue team at Dragobrat (1200 m a. s. l.).

The Figure 2 shows that there is a sharp increase in snow depth during snowfalls and a decrease mainly during the thaws. The same trend is observed at all the region stations.

The peculiarity of snow distribution in the Tisa basin is the extreme snow accumulation at the stations and posts, which are located at lower elevations (400-600 m a. s. l.), such as Nizhniye Vorota, Mezhorie and posts Kolochava, Russkaya Mokraya, and they are only a little different from those ones which placed 1000 m higher (Plai and Pozhezhevskaya). This is due to the great wind activity around the avalanche stations and drifting away of snow cover from site fences. The extreme snow depth at most posts placed in valleys (350-650 m) exceeded 100 cm. For example at Yasinia 106 cm, Lugi 108 cm, Russkaya Mokraya 180 cm, Ust-Chornaya 170 cm, Kolochava 134 cm, Podpolozie 106 cm, Dolgoe 100 cm, Svalyava 104 cm were measured.

It is necessary to mention the considerable snow accumulation on Dragobrat plateau, where the Yasinia control-and-rescue team ran observations rather regularly. The extreme snow depth exceeded 3 meters there, confirm the conclusion of Dr. Grishchenko (Grishchenko V., 1969) about exclusive snowiness of Dragobrat plateau in the Carpathians, which is based on the 10-year observation data of the UHRI avalanche team. As it was observed at AS Plai and Pozhezhevskaya AS equipped with snow markers located at remote measuring locations, the snow cover depth exceeded 3-5 m.

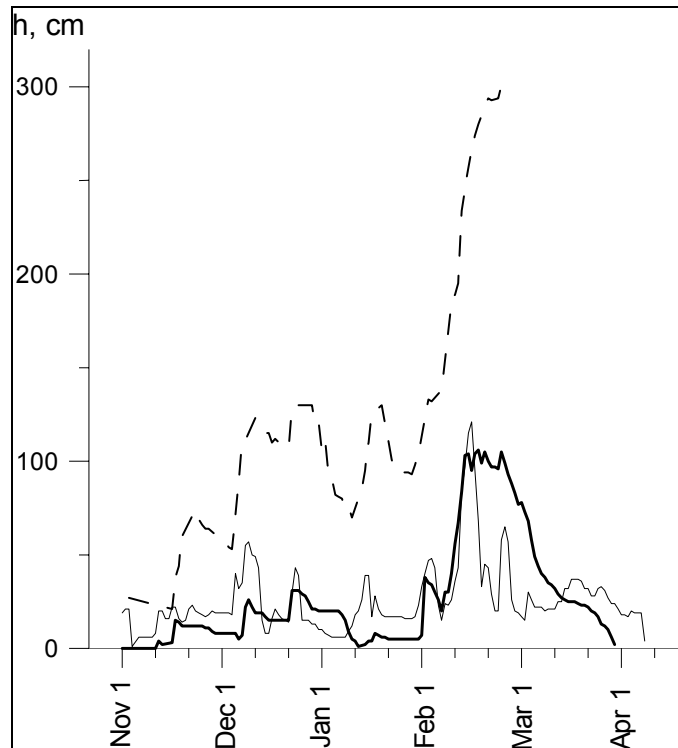


Fig. 2. The variation of snow depth at the stations Pozhezhevskaya (ordinary line), Yasinia (bold line), Dragobrat (dashed line).

During the previous 60-year's period it was observed 11 extremely snowy winters. The winters are considered much snowy if the water deposit is more than 200 mm in highland basins (Maslova T., Grishchenko V., Sosedko M., 1999). The winter 1998-1999 was the extremely multi

snowy: the average storage of water in snow cover was 200-380 mm (maximum about 480 mm) in highlands and 100-150 mm in lowlands.

According to the snow data collected at meteorological stations and posts, it was cleared up that magnitudes of snow depth (100 to 200 cm on plain and more than 400 cm on highland) and water supply (140 to 400 cm) exceeded the multi-year extreme ones on different altitudes as much as 2.4 to 5.5 and 1.8 to 7.4 times respectively. Average, within the river Uzh basin, they exceeded 2.9 times on snow depth and 3.1 times on snow supply, 4.7 and 3.1 within the Latoritsa basin, 3.2 and 3.4 within the Rika basin, 3.8 and 4.6 within the Tisa basin respectively. It blocked all the passes of Transcarpathian, namely Uzhokski, Veretski, Torunski, Yablonetski, for a few days.

The same situation was observed in mountain region of Europe, especially on the northern flank of the European Alps where the deep of snow cover as a result of heavy snows reached 2-3 m. As the result the worst snow avalanche period in over 50 years was observed. All alpine countries suffered damage and loss of life. In Switzerland 12 people were killed and 38 people were killed in Austria (from report Betty Sovilla and Urs Gruber "Avalanche winter 1999. The importance of the snow entrainment in catastrophic avalanches " at the II International Conference on snow avalanches in Kirovsk , Russia, 2001).

The extraordinary snow accumulation caused the abundant avalanche phenomena in the Tisa basin. As whole 143 avalanches were observed, of which 36 by avalanche stations, 4 by control-and-rescue service, and the rest were fixed by one of the authors during the brief round flight.

For the first time of the more than 30-year observation period, the avalanches as long as 3 km and by volume up to 2.5 million m³ were marked in the Carpathians. The avalanches were marked within the elevation range 350 to 1950 m abs. Most of them consist of dry fresh and storm snow. The avalanches destroyed more than half square kilometer of forest, and blocked motor roads as well as railways for a few hours. A huge avalanche, which came down from plateau Krasnaya at 1500 m, destroyed a house and killed a woman; the height of the avalanche cone at stopping zone was above 25 m. About 200 rescuers of Ministry of Emergency took part in search the victims.

In order to compare the scales of the avalanche phenomena in the Tisa basin during the mentioned winter table 1 is presented. It illustrates the information which has been collected by the UHRI avalanche team during the field observations which take place usually from November to April and quite often with helicopters (the observations were carried out not only in Zakarpatie, but also for the whole Ukrainian Carpathians) and the detailed avalanche information collected by the AS Plai and Pozhezhevskaya on the avalanche sources situated next to them.

Table 1. Amount of avalanches in the Ukrainian Carpathians for the period of 1986-2000

Year	Amount of fixed avalanches				Total avalanche snow volume, (m ³)
	AS Pozhezhevskaya	AS Plai	Sum	UHRI AT	
1986	4	18	22	233	4019140
1987	26	7	33	302	3517150
1988	32	3	35	253	-
1989	14	6	20	99	37442251
1990	2	1	3	27	212500
1991	2	-	1	112	131250
1992	30	1	31	-	-

1993	14	12	26	114	2889150
1994	9	10	19	84	1921800
1995	21	31	52	26	-
1996	27	8	35	130	21008200
1997	15	-	15	11*	150000
1998			30		
1999	27	36	63	>100	10,000000
2000	15	3	18		

In winter 1998/99, avalanches were observed in all the explored local basins of the Tisa basin, namely the Uzh, the Latoritsa, the Borzhava, the Rika, the Tereblya, the Teresva, the Chornaya Tisa, and the Belaya Tisa.

Taking into a count a limitation of the explored area and information about fixed avalanches, it may be affirmed that the winter 1998/99 was remarkable in number of descended avalanches. It is correctly confirmed by observations of amount of avalanches near the Plai and Pozhezhevskaya AS, where there are observed objects unchangeable and a few avalanche cores beside the stations, and the same observers. For the whole observation period, it was the winter 1998/99 when the great amount of avalanches was marked. There were 36 avalanches at Plai and 27 at Pozhezhevskaya. Evidently, there were more avalanches, but as "Plai AS Technical Report" said, "because of low visibility many avalanches were not registered".

The avalanche season is defined as the period since when 100 mm of snow falls out or 30 cm and more snow cover is formed till the melting season when snow depth melts due to thaws down to a value lower than 30 cm. It began, naturally, on highland, on November 20, 1998 near the Plai AS and on December 8, 1998 near the Pozhezhevskaya AS. According to avalanche conditions 12 avalanche-dangerous periods (ADP), which are determined with the principles of avalanche prediction for fresh, stormy, and wet snow were noticed at the Plai AS. 36 avalanches were marked (25 of storm snow and 11 of wet snow). It is necessary to mention the low visibility due to the persistent snowfalls observed almost uninterruptedly from January 25 to March, and therefore a lot of avalanches were not marked. 26 avalanches went down (3 of fresh snow, 10 of stormy, and 12 of wet snow) at Pozhezhevskaya AS.

With the calculations and comparison done, the extraordinary snowy of the winter 1998/99 was cleared up. During this winter, the remarkable magnitudes of snow cover depth and water supply were noticed and they exceeded the long-term observed values about 2.5 to 3 times in lowlands and 3 to 4 times in highlands.

The conditions of formation and distribution of avalanches, which were exactly caused by extraordinary snowy of the explored area and which were favorable for forming avalanche with length up to 3 km and volume above 2 million m³ of snow were cleared up. In many cases avalanches blocked the roads frequently, destroyed forest and caused human loss.

References

- Grishchenko V. An estimate experience of a highland area for the purposes of winter recreation. – MGI (in Russian), vol. 80, 1969, pp. 94-98.
- Maslova T., Grishchenko V., Sosedko M. Much snowy winters in Zakarpatie and avalanche activity // Proceedings of the UHRI, (in Russian), 1999, vol. 247, pp. 144-149.
- Vancho I. A studying of meteorological reasons of the largest floods on the river Tisa // Carpathians' influence on the weather. – Budapest. Academia Kiado, (in Russian), 1963, pp. 123-131.