Rožnovský, J., Litschmann, T., (eds): Mendel a bioklimatologie. Brno, 3. – 5. 9. 2014, ISBN 978-80-210-6983-1

Extreme poor snowfall condition in winter 2013/2014 in comparison to previous decade of winters in the catchment area of Hučavy

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Abstract

The paper is focused on an overall assessment of water supply in snow cover from data gathered by field measurements of winter seasons between 2004 – 2014 in a small mountain catchment Hučava (caldera of Poľana) especially at last winter season 2013/2014.Calculation of water reserves in snow cover also reflects the impact of forest cover. Temporal and spatial distribution of snow cover has been processed in ArcGIS software environment and the results show that the distribution and duration of snow cover is very variable, from lack of water supply in the snow (winter 2014) to maximum snow water equivalent of 525.4 mm (April 2013), which represents half the average annual rainfall on top of Poľana mountains.

Key words: water supply in snow cover, Hučava

Introduction

Snow in the global energy and water budget plays an important role, due to its high albedo and the ability to store water (TABARI *et al*. 2009). Scenarios of climate change (IPCC, 2013), expected changes in quantity, temporal and spatial distribution of snow on the surface and thus the impact on water resources dependent on snowmelt. Retreat enlargement permanent snow cover deteriorating hydrological regime (in particular water availability during the year), not only for Slovakia but also in many areas of the world. Temporal and spatial distribution of snow cover is important information from multiple points of view. Snow cover is an important hydrological basin, climate and biological agents. Significantly on the distribution of snow cover affects forest cover by influencing the accumulation and melting snow under the canopy compared to open area. This difference is dependent on specific habitat conditions and weather conditions of the winter (GELFAN et al., 2004). From a hydrological point of view, it is important to know the laws that govern as well as the total amount of snow cover in winter, snow accumulated in the basin. Snow cover closely depends on the air temperature and rainfall, and thus of changing climatic conditions. As the environmental factor is not the only reservoir of water for the spring season, but snow also protects the soil and vegetation from strong frosts. (KADLEC & KOVÁŘ 2008).

Snow, however, also acts as the negative. Especially in the winter with the presence of abundant snow cover may damage crops. A large amount of snow cover in mountainous areas restricts the movement of people and the risk of avalanches, which may hit the low-lying contiguous areas of forest. The other negative effect of snow cover is rich spring-winter floods, occurring especially in the steep warming accompanied by rain precipitation. Conversely, the absence of a minimum amount of snow cover lead to drying of the country to warmer and drier spring period and also has a link with the occurrence.

Material and methods

For Slovak conditions and, in particular, for the calculation of the water supplies in small mountain catchments are the most credible the results of the measurements, whereas a network of meteorological stations of the projection is not thick enough, especially at higher altitudes. Monitoring of the characteristics of the snow cover from the winter season 2003/04 is up to the present, in the Poľana in the Hučavy basin (fig. 1). The monitoring methodology developed by the Department of personnel of the natural environment at the Technical University in Zvolen and conforms to the industry standard: 3109:02 OTN and in this work it further use. Hydrophysical characteristics of the snow cover are found the mass weighting method with use of snowtube. Snowtube has a cross section of 50 cm^2 weight.

Monitoring of the basic properties of snow has been carried out on a monthly basis. We conducted 5 measurements of snow water equivalent and the density. In open areas, such as in plantations, we carried out with the aid of a portable carrier 20 findings of the heights of the snow. Characteristics of snow cover on the height tranzekt we have found from 600 to 1280 meter above sea level in height intervals of approximately 100 meters - free area and the area for forest. We used measuring standard by the SHMÚ. After previous experience, that more donations would be sustainable and statistically unimportant. Less donations, however, could prove to be the accuracy of the results now (HRÍBIK & ŠKVARENINA 2005).

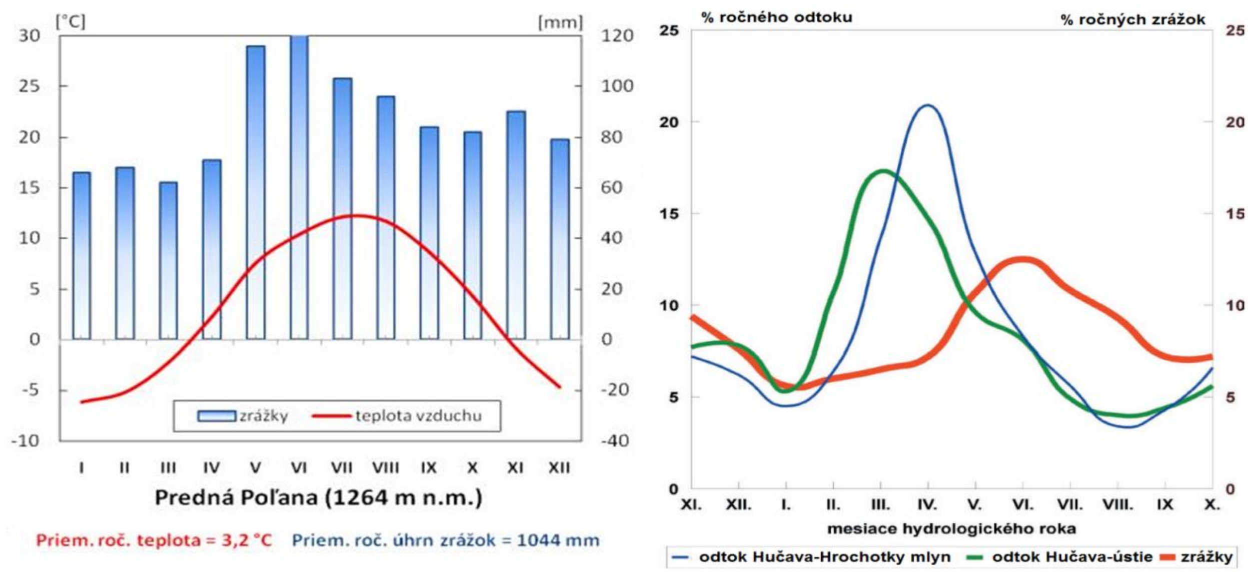

Fig.1 Climate - graph a hydro - graph for Hučava basin (*HRÍBIK et al.,* 2007)

The whole process is carried out in the computer processing of the results of the field monitoring of the environment. Analysis of water in snow cover and its temporal and spatial distribution on the surface of the basin we carried out the tools and resources offered by the GIS environment, ArcGIS 10. The whole process is carried out over a digital model of the terrain of the third generation of the DMR 3 (grid cell size 10 x 10 meters). After getting the input data, the first step was in defining the catchment area, which we have identified on the basis of the DMR and the closing of the flow profile (limnigraphic station Hrochotský mlyn). With the following specified parameters generated by the catchment area of the module: *Spatial Analyst Tools /Watershed/ Hydrology.* For the next course of action, it was necessary to divide the area of the forest and the area of the basin and create a digital model of the terrain for the forest and the free surface. To the end, we provide the model of Spatial Analyst Tools/Mask, where the mask was vector Extraction/Extract by a layer of forest economic recovery plan of the 2011 crop. A similar process was used for forest and also a separate DMR for free area.

The next step was determining the dependence between the altitude (independent variable) and then changing the value of the water and the amount of snow and the height of snow (dependent variables), we decided to make a linear regression of dependency (average coefficients of determination 0.75-0.79). This dependency is used by SHMÚ and hydrophysical characteristics of the snow cover detected also in the interpretation of our expeditionary measurements. On the basis of computed altitude values as an independent variable, based on the regression between values and the amount of snow cover and water-dependent transformations, such as the data transferred into the program through snap-in map algebra Spatial Analyst Tools/Map Algebra/Raster Calculator. The underlying layers of the digital models of terrain analysis are for free area and the area of the forest basin. This procedure created maps of the distribution of water and the amount of snow cover. Derived maps decremented the amount of snow cover and water value of statistical indicators for the snow cover (in mm). We extracted the value specifically for the free area and the area of forest. Supply of water in snow cover catchment area (in million m^3) of water was detected as the sum of the values of snow cover on the desktop, open area and together. For ease of interpretation and to check the accuracy of the maps have been created transparent map outputs for each winter season, which arise by the classification image using Spatial Analyst Tools / Reclass / Reclassify. A similar procedure was used in the work of HRÍBIK *et al.*2008: Zimné zásoby snehu v malom horskom povodí Studeného potoka v orografickom celku Západné Tatry.

Results

Snow water equivalent is the most concise characteristics from the perspective of hydro-physical properties of snow. It is the most important information obtained within the framework of information on snow cover. It is closely dependent on the amount (in our case, the coefficient of determination, R^2 = 0.85 for the GOP and R^2 = 0.80 for forest) and the density of the snow cover, and is defined as the amount of water that would be a thawing of snow cover. Given in millimeters and applies as: 1 mm of water per 1 m^2 is 1 liter of water.

It has seen that culmination occurs mainly in the months of February and March, as the amount of snow, which provesthe relationship between these characteristics. Interesting is the fact that the maximum snow water equivalent at the time of its culmination value is the value of 525,4 mm (April 13), representing almost half of the average annual rainfall, rainfall on top of Poľana (1145 mm) bound in the form of snow. In contrast, last winter (2013/2014) we note the lack of snow on most of the area.

Considering the diversity of both the weather and the natural environment is the amount, distribution and duration of snow cover is very variable. Calculation of the water supply in snowpack was million. m^3 (Fig. 2), we note that the values are within the ten-year data variable to the extent that the difference between maximum and minimum water supply catchments in time is the culmination of more than 20 - fold. Maximum water supply (March 2006), was at 8,295 million m^3 while the minimum (February 2014) the water supply of snow cover accounted for only 0.352 million m^3 of water (February 2014). When expressed under the two winter seasons can be simplified in the assessment highlights winters in terms of water availability in snow cover in the basin held: 2006> 2005> 2013> 2012> 2004> 2007> 2009> 2008> 2010> 2011> 2014.

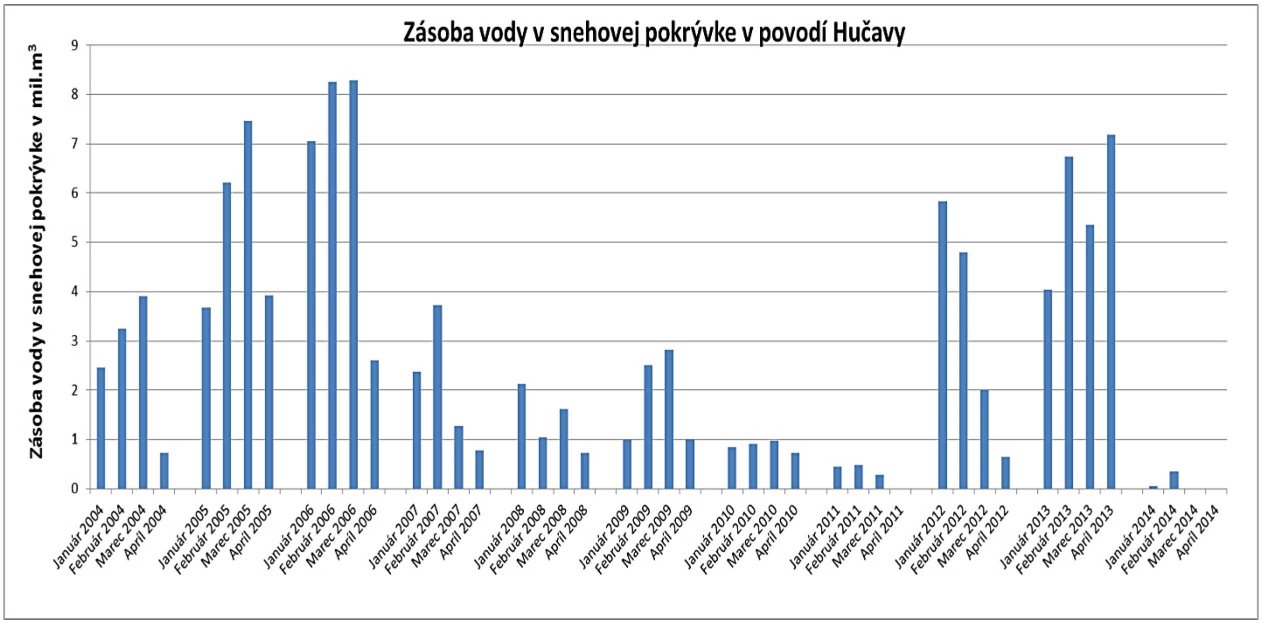

Fig.2. Supply of water (in million m^3) bound in snow cover in the watershed Hučava (2004-2014)

Graphic evaluation of snow water equivalent (Fig. 3) also captures the spatial variation of the catchment area. The colour range is selected from white (absence of snow) colours to deep red colour (maximum water depth values). Boundary of the basin boundary maps are most altitudes. Well it is therefore observable rising water value snowpack in altitude basin. In forest stands watching the generally lower water depth values over the free surface (best seen in March 2004).

Conclusions

The paper aimed to take stock and mutually compare water supplies in the basin Hučava in the years 2004-2014. Calculation of water reserves in snow cover is considering the impact of forest cover as in Slovakia is the most mountainous and foothill catchment, especially at higher altitudes forested. From the hydrological point of view can be considered snowpack water reservoir, which is variable and highly dependent on climatic conditions of environment. This variability of water resources and demonstrate our results within 11 - years monitoring. The snow cover is therefore accumulated significant reserves of water. This spring depends on the weather or sudden continuously released into surface and subsurface runoff. In the case of a severe warming associated with abundant rainfall, these water supplies, flooding potential danger of melting snow. Conversely earlier spring retreat, or even complete absence of permanent water and abundant snow cover is a major cause of faster and stronger spring air temperature rise. If there is no moisture deficit, caused by a lack of snow, spring rains sufficient coverage, this condition may lead to the formation of prolonged droughts and stronger with adverse, sometimes disastrous consequences for agricultural production and water management.

On the other hand, has a certain scale influence on climate conditions alone snowpack. Views on global climate change, its speed, impact and degree of fault may often vary, sometimes they are quite contradictory. However, it is undeniable that it has become a reality. General climatological analyzes confirm the change in the duration of snow cover, as well as the decline in the proportion of precipitation falling on the earth's surface in the form of solid state (except the highest mountain positions).

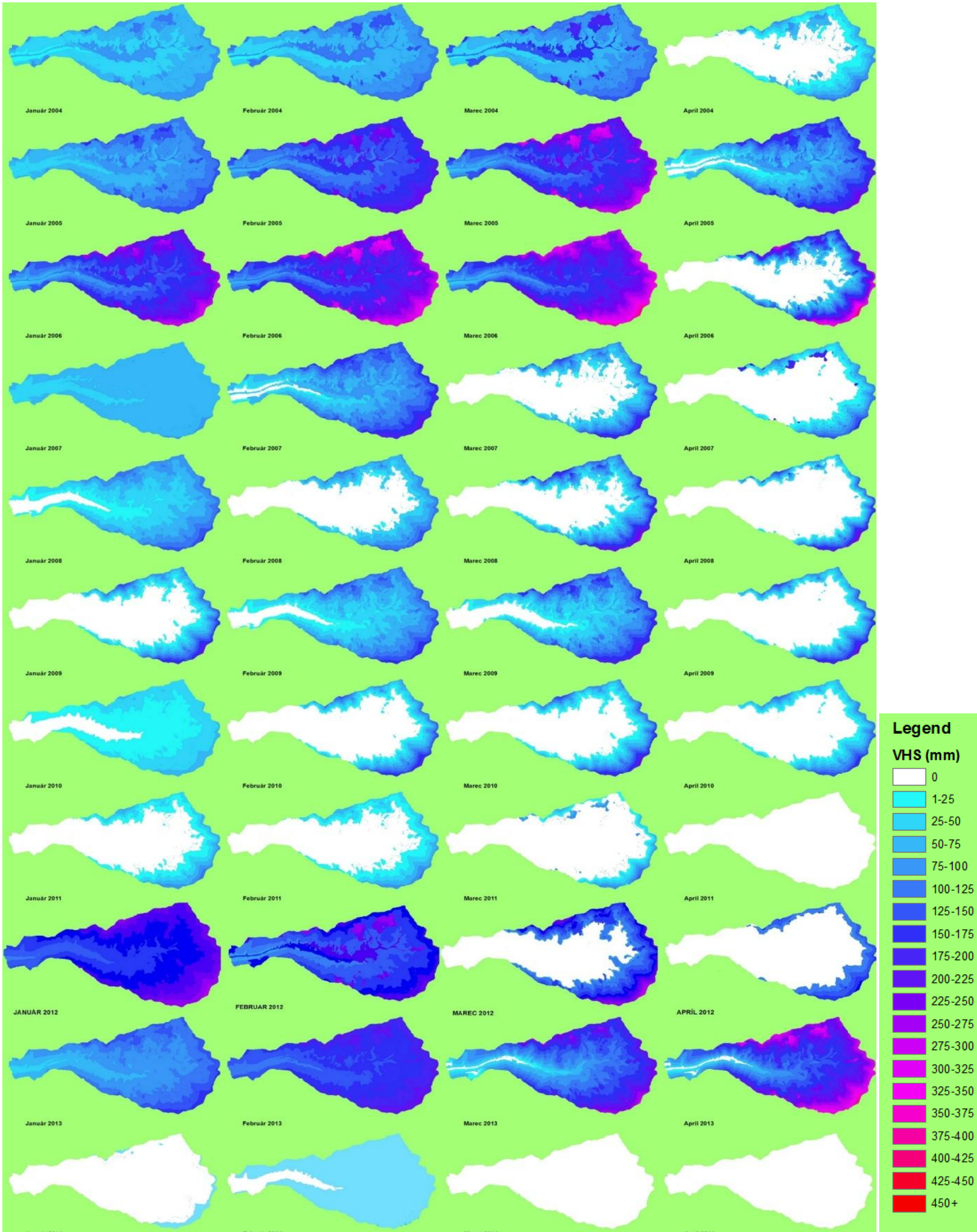

Fig. 3 Temporal and spatial distribution of water depth values in the basin Hučava (2004-2014)

The most significant loss of solid precipitation was recorded at altitudes 1,000 to 1,500 m (may be included here and basins of central Slovakia). Areas below 1000 m n. m. begin to significantly dominate liquid precipitation, especially at the beginning and end of winter. Synergistic effect of changes in precipitation and temperature rise disrupts the natural water cycle, since its end effect snow melting. Therefore, research snow conditions and water resources tied up in snow cover has legitimate meaning.

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Acknowledgements

This post is the result of the implementation of the project: a centre of excellence for decision support in the Woods and from ITMS: 26220120120, supported by research and development, operational programmes financed by the ERDF (20%).

We support research activities in Slovakia/project is co-financed by EU funds/. This post is also supported by research grants for the VEGA 1/1130/12 (40%), in VEGA 1/0281/11 (10%), in VEGA 1/0257/11 (10%) of the Slovak grant Agency for science and the Agency for the promotion of research and development within the framework of the Treaty no APVV 0423-10 (20%).

Summary

Predkladané výsledky poukazujú na veľkú variabilitu snehových zrážok malého horského povodia. A to od absencie snehovej pokrývky (zima 2014) až po polovicu priemerných ročných zrážok (525,4 mm) na vrchole Poľany viazaných vo forme snehu (apríl 2013). Táto variabilita snehových zrážok sa prejavuje aj vo výsledkoch v rámci 11 – ročného monitoringu. V lesných porastoch sledujeme všeobecne menšie hodnoty výšky snehovej pokrývky aj vodnej hodnoty snehu ako na voľnej ploche. Výpočtom zásob vody viazanej v snehovej pokrývke v povodí Hučavy (v miliónoch m^3) konštatujeme, že hodnoty sú v rámci sledovaného obdobia rokov 2004-2014 premenlivé až do tej miery, že rozdiel medzi maximálnou a minimálnou hodnotou vo vrchole zimy je viac ako 20 – násobný. Maximálna v snehu viazaná zásoba v povodí bola 8,295 miliónov m^3 vody (marec 2006), zatiaľ čo minimálna zásoba vody v snehovej pokrývke predstavovala iba 0,352 m^3 vody (február 2014). Rozdielne čísla každej zimy ukazujú, že sledovanie snehových pomerov v malých horských povodiach je dôležité či už pre predpoveď povodní s topiaceho sa snehu alebo naopak následnej suchej periódy s jeho absencie aj vo vyšších nadmorských výškach.

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