

THE IMPACT OF FLASH SNOW-MELT – PRECIPITATION FLOOD ON OUTFLOW DENUDATION FROM SMALL LOWLAND CATCHMENTS (ON EXAMPLE OF LEFT-BANK TRIBUTARIES OF LOWER WIEPRZA, NORTH POLAND)

W. Florek, J. Jonczak, C. Princ

*Pomeranian University of Słupsk, Dept. of Geomorphology and Quaternary Geology,
Słupsk, Poland
florekw@pap.edu.pl, jonczak@pap.edu.pl*

In January 2006, in several small catchments of left-bank tributaries of the Wieprza near Stary Kraków (Figure 1) investigation on the chemical and physical-chemical properties of water discharged into the Wieprza by streams was begun, and a quantitative and qualitative evaluation of the surface runoff and the intensity of the transport of dissolved and suspended material was undertaken. Between the end of January and beginning of February 2007 a rapid warming was observed in the area of the catchments, which caused fast melting of the snow cover. The simultaneous occurrence of considerable rainfall brought about the activation of surface runoff of a high intensity.

The aim of the paper is the evaluation of the impact of the observed surface runoff on the chemical composition of waters, transport of suspension and of dissolved substances out of the catchment in two left-bank tributaries of the lower Wieprza. The characteristic feature of these streams is the deep cut of their valleys into quite flat ground formed by dammed sediments (clayey silts with thin insertions of very fine-grain sands or varved clays) occurring on boulder clays, which could indicate a high intensity of denudation processes in the past (probably during the Late Vistulian). What is noteworthy is also the highly developed hydrological network within the catchments. The alimentation basis of the streams are seeps of ground waters from valley slopes and periodically drainage waters. The results of the research of 2006 concerning the volume of discharges in streams and the load of suspension and concentrations of dissolved substances indicated a small intensity of denudation processes within the analysed catchments. The suspension transport ranged from 3.0 to 48.6 kg·d⁻¹ in stream A and 5.4-89.5 kg·d⁻¹ in stream B, with discharges of 10-20 dm³·s⁻¹ in stream A and 10-40 dm³·s⁻¹ in stream B.

Between the end of January and beginning of February 2007 within the analysed catchments, a rapid warming occurred causing intense melting of the about 30-centimetre snow cover. Additionally, rainfall occurred in that period. As a result, large quantities of water started flowing on the surface over the frozen ground into the streams. Discharges several tens times higher than the average were recorded in that period. In stream A the discharge was 500 dm³·s⁻¹ and in stream B 1500 dm³·s⁻¹. The rapid increase in discharge in the streams caused activation of suspension transport in both catchments. In streams A the suspension content in the flood period was 56.5 mg·dm⁻³, while in stream B, 160.3 mg·dm⁻³. In both cases these are values several times higher than the values observed in periods of average water discharge. In the flood period, a considerable decrease in the concentration of some dissolved substances, including Na⁺, Ca²⁺, Mg²⁺ and Cl⁻, was observed.

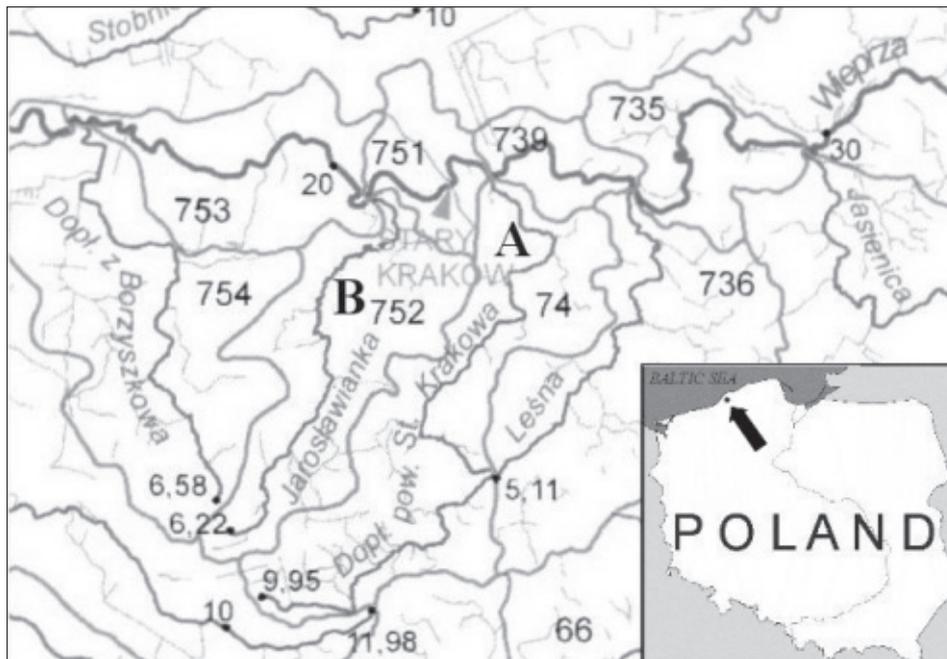


Figure 1. Location of analysed streams against hydrographic division of the Wieprza catchment in the area of Stary Kraków (Atlas Podziału Hydrograficznego Polski, 2005)

Simultaneously, an increase in the concentration of ammonium nitrogen ($\text{NH}_4\text{-N}$), potassium, total organic carbon and Kjeldahl's nitrogen (N_k) was observed in both streams. The maintenance of high concentrations of K^+ and $\text{NH}_4\text{-N}$ despite increased discharges is caused by a high mobility of these ions in the environment and susceptibility to leaching from the ground both in agricultural and forest catchments. On the other hand, the high concentrations of total organic carbon and N_k are related to the activation of suspension transport which partially has an organic character. In the ultimate balance, the sum of substances dissolved in water in the flood period was even several times lower than in a period of average discharge, which is indicated by the content of the so-called dry residue.

For the interpretation of denudation processes within the catchments, the daily loads of substances carried out of the catchments are of higher significance than their concentrations in water. Examinations showed that phenomena of an extreme character, like the observed rapid surface runoff, have a great impact on the transport of matter out of the catchment, and thus play a basic role in the shaping of the catchment morphology, especially of the very stream valley. The daily suspension load during the flood period in stream A rose 145 times and in stream B 780 times in comparison with the mean value for the remaining research period. 2440.8 kg of suspension daily was carried out of the catchment of stream A, and 20774.9 kg out of the catchment of stream B. During the thaw period of 2007 the unit suspension load was about two times higher than the load of the dissolved substance, while in average conditions the load of the dissolved substance was many times (even a hundred times) higher than the unit suspension load. This is an even larger diversity of the relationship of these two values than it was documented by Kostrzewski *et al.* (1992) for the catchment of the Młyński Potok, where during the flood in July 1988, the unit suspension load was on average five times higher than the load of the dissolved substance. In average conditions, a domination of 10-100 times of the processes of chemical denudation over the processes of physical denudation was observed there.

The occurrence of a flood lasting several days causes results, which in conditions of average discharges would take place only in several years' time. The observed flood also played a key role in the transport of particular substances dissolved in water. Regardless of the fact whether during the flood lower or higher concentrations of substances, with regard to the average situation, were observed, taking into consideration the value of the discharge, the flood period decidedly influenced the annual load of particular components in both catchments. During one day of the flood, loads of dissolved substances, higher than outside the flood period by several

to several hundred times, are transported out of the catchment. The sum of dissolved substances transported daily during the flood period out of the catchment of stream A was 3629 kg and of stream B 10627 kg.

In the flood period, a decrease in the value of water reaction (acidification) by about one unit in comparison with the remaining research period was observed in both streams. This decrease should be attributed to the variable intensity of the activation of ions of acidic and alkaline character in the flood period.

References

- Atlas Podziału Hydrograficznego Polski*, 2005: Instytut Meteorologii i Gospodarki Wodnej, Warszawa.
- Florek W., Jonczak J., Princ C., 2007: *Wpływ spływu powierzchniowego na transport zawiesiny i chemizm wody lewobrzeżnych dopływów dolnej Wieprzy*. In: A. Kostrzewski, A. Andrzejewska (eds): *Program zintegrowanego monitoringu środowiska przyrodniczego a zadania ochrony obszarów Natura 2000*. Warszawa: 269-279.
- Kostrzewski A., Klimczak R., Stach A., Zwoliński Z., 1992: *Wpływ procesów katastrofalnych na funkcjonowanie współczesnego systemu denudacyjnego obszarów młodoglacjalnych – Pomorze Zachodnie*. *Badania Fizjograficzne nad Polską Zachodnią*, 43A: 55-82.

