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The dynamics of suspended and dissolved transport in a High-Arctic glaciated catchment in ablation seasons 2005 and 2006, Bertram River, Central Spitsbergen

Mateusz Strzelecki*

Faculty of Geographical and Geological Sciences, Adam Mickiewicz University, Poznań, Poland

According to Warburton (1999) proglacial river geoecosystems provide a key link between glacial processes and the wider (paraglacial) environment. One of the most sensitive indicators of changes in glacial environments which inform about interaction between glacier, climate and landscape change are suspended sediment yields (Hodgkins et al. 2003). Many studies of sediment storage were made in alpine regions, however relatively few researches have been carried out in the High-Arctic locations, what caused a gap in the understanding of fluvial matter transport in glaciated catchments.

This paper presents data from investigations on denudational processes carried out on the proglacial Bertram River located in Petuniabukta region in Central Spitsbergen. Major research data and conclusions are also summarized on the poster prepared for the conference poster session.

Catchment of the Bertram River exhibits many interesting geomorphological characteristics when compared to other proglacial river geoecosystems. Bertram River is distinguished by a waterfall system, which divide 4.9 km^2 catchment into two parts: upper – glaciated part located on mountainous plateau, and lower – where braided planform was formed within the bottom of the Ebba River valley. About 60% (2.9 km^2) of the total area of the Bertram catchment is occupied by small cold-type Bertrambreen, which since LIA is in a continuous retreat (Kłysz et al. 1989)). The lithology of glaciated part of the catchment includes Precambrian metamorphic rocks, Paleozoic dolomites, limestones, shales and sandstones (Szczuciński 2003). Sandstones contain iron compounds, which turns red water colour. The

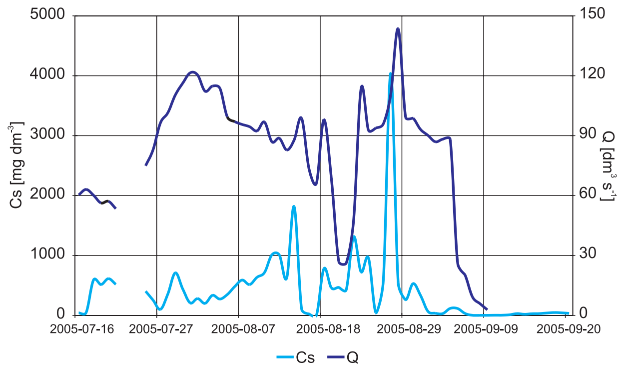

Fig. 1. Suspended sediment concentration Cs and river discharge Q in melt season 2005

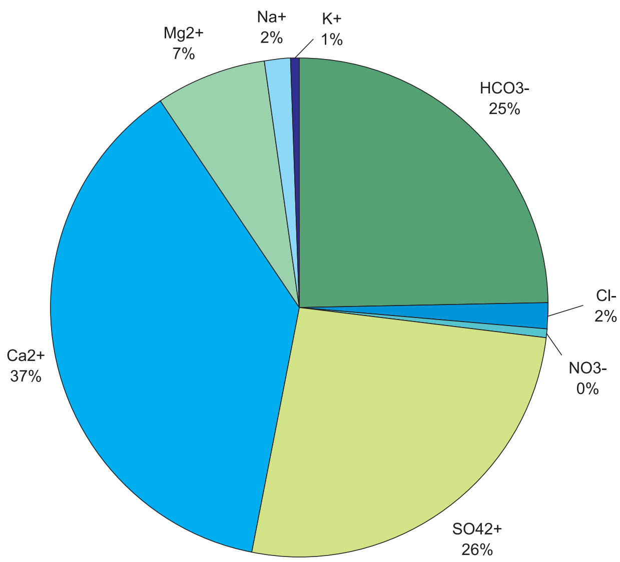

Fig. 2. Average chemical composition of Bertram River water in 2005 ablation season

* e-mail: mstrzelecki@mediasynergia.pl

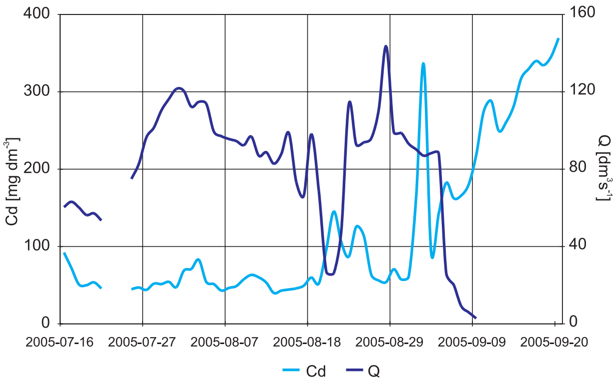

Fig. 3. Solute matter concentration Cd and river discharge Q in melt season 2005

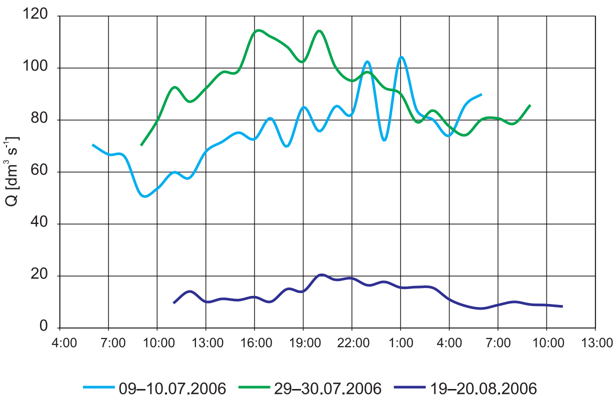

Fig. 4. Changes of water discharge Q during three days of 24-hour hydrochemical monitoring

lower part of the catchment is covered with unconsolidated and poorly sorted glaciofluvial deposits.

During the first expedition, which took place in melt season 2005, the main purpose was to observe the seasonal changes in discharge and concentration of suspended and dissolved matter (Fig. 1, Fig. 2) Investigations on chemical composition of glacial meltwaters (Fig. 3) were carried out simultaneously with observations of suspended sediments to estimate the participation of chemical denudation in the total rate of catchment denudation.

Daily hydrological and hydrochemical data and samples, collected between 16th July and 20th September 2005, were analyzed together with geomorphological surveys and meteorological observations. One of the most interesting events happened between the 27th and 28th of August when after few days of precipitation, strong and warm foehn occurred and intensified ablation causing bankfull discharge and extensive flood in the Bertram River and next in the Ebba Valley also. Extreme event which disturbed the seasonal distribution of fluvial transport served as a basis for 2006 detailed measurements.

The main purpose of the second campaign of measurements was to observe the diurnal fluctuations of matter concentration and stream discharge (Fig. 4) during three selected days during ablation

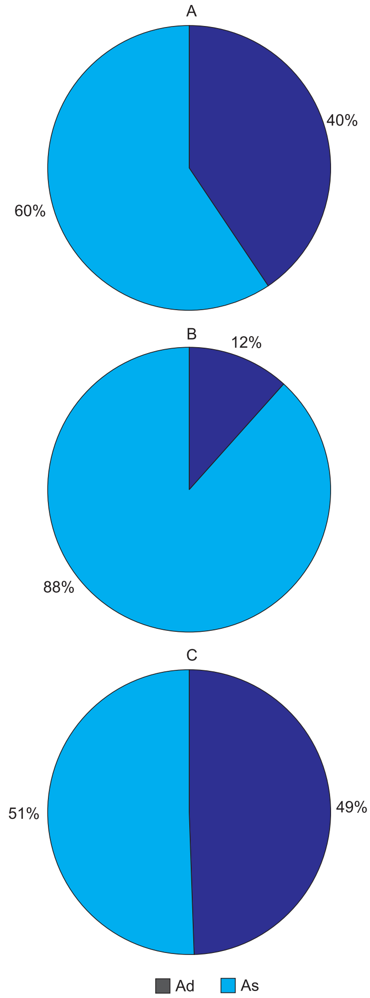

Fig. 5. Proportional participation of suspended sediment fluxes As and solute matter fluxes Ad in the total matter flux form the Bertram River catchment during 24-hour monitoring

A: 09–10.07.2006, B: 29–30.07.2006, C: 19–20.08.2006

season 2006. 24-hour hydrological and hydrochemical surveys were carried out:

a) at the beginning of the July (09/10.07.2006) in the phase of increasing discharge,
b) at the end of the July (29/30.07.2006) during the phase of the highest summer discharges,
c) at the end of August (19/20.08.2006) in early phase of the decay of water flow in the river.

The final results of the measurements revealed the compact dependence between the matter fluxes and water discharges. During the first observing season about 60% of denudated matter were suspended sediments (Fig. 5A). At the peak of the ablation season 2005 the amount of suspended matter in the total load of the fluvial transport increased to 88% (Fig. 5B). The results form the last survey from the second decade of August showed that during period of lower discharge the amount of suspended and soluted matter fluxes was almost equal (Fig. 5C).

Diurnal observations from 2006 season indicate different rate of reaction of fluvial system on weather

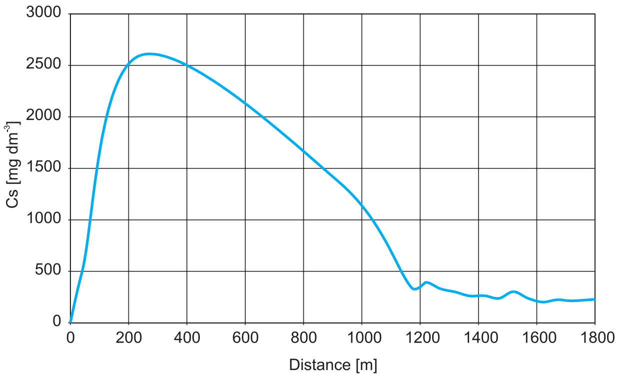

Fig. 6. Changes of suspended sediment concentration Cs along longitudinal profile of the Bertram River between the glacier source and river mouth

conditions. Maximum discharges were registered from 4 p.m. till 1 a.m. on the following day. Although different rate of transport and loads of suspended and solute matter during 24 hours demonstrate their significant dependence on meteorological conditions and definitely weaker dependence on bed rock lithology.

The last part of the observation in melt season 2006 was hydrochemical mapping carried out on the main channel of Bertram River. The research assumed observing the changes in water chemistry and channel morphology from the glacier front, through the waterfall system to the stream channel, where Bertram River joins the Ebba River. The strong connection between waterfall system and the change of suspended sediment concentration were found (Fig. 6) as well as the changes of solute matter concentration in the lower part of the catchment. Waterfall system located between the 920–1170 meter of the river length caused the dispersion of the suspended sediments and slow down the process of braided-channel pattern formation. The huge difference between chemical composition of meltwaters from the upper and lower part of the catchment will be also discussed.

Both researches from 2005 and 2006 observation seasons enable to present the detailed image of the geomorphological and hydrological conditions of seasonal and diurnal variations in suspended sediments and solute transport in High-Arctic catchment.

Literature

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