



Changes in microbial concentrations during summer and winter extreme runoff events in a catchment featuring mixed land use – pilot study

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Introduction

Changes in river flow during summer and winter extreme events are often accompanied by changes in bacterial load. This is a major concern, especially in areas where drinking water reservoirs are located. The pilot study was carried out in August and December of 2010 in Ryjak catchment (45 km²) located in the Carpathian Mountains. The research took place during a summer storm flood and a snowmelt flood. The main purpose of the study is to determine the influence of changes in flow rates on microbial concentrations in a catchment featuring mixed land use.

Study area

Ryjak Stream is a right tributary of the Wisłoka River, where a drinking water reservoir is being planned. The Ryjak catchment is located in the Beskid Niski Mountains in the eastern part of the Outer Western Carpathians in southeastern Poland. Two sampling sites were selected – one at the mouth of the catchment (R2) and another on the boundary of Magurski National Park (R1). This boundary also happens to separate areas with different land use. The upstream part of the catchment is characterized by mixed land use, with forests accounting for 65%, arable land 18% and pastures 17% of the catchment. Since there is no sewer system in this part of the catchment, most household and farm wastewater is discharged straight into stream water. The downstream part of the catchment consists primarily of forest (93%) and pasture (7%) and is protected as part of Magurski National Park.

Materials and methods

Water levels were recorded at both sampling sites in 10-minute intervals. Water and air temperatures were recorded using the same time intervals. Rainfall data were recorded by a standard rainfall gauge located approximately 1 km from the R1 sampling site. Water samples for Coliform and Escherichia coli analysis were collected in sterile glass containers, later cooled and transported to an accredited laboratory within less than 10 hours from sampling time. Microbiological analysis was performed using IDEXX Colilert Quanti Tray/2000.

Results

The results obtained at the R1 sampling site during the storm flood show a strong correlation between runoff and microbial concentration. During the peak of the flood, the coliform concentration reached 155,300 CFU/100 ml, and Escherichia coli concentration reached 23,600 CFU/100 ml. This represents a 6-fold and a 13-fold increase – respectively – in coliform and Escherichia coli concentrations over the course of first 3 hours of the flood. Furthermore, a 64-fold and a 32-fold increase, respectively, was noted with regard to the highest monthly concentrations on record at R1. This demonstrates the immense importance of summer floods in the influx of bacteria to Wisłoka River and consequently to the drinking water reservoir being planned on the river. On the contrary, the midwinter snowmelt flood was found to be considerably less important. Microbial analyses performed in December of 2010 at sites R1 and R2 indicated that coliform and E. coli concentrations reached 7,900 and 1,200 CFU/100 ml (respectively) at R1 and 6,700 and 1,300 CFU/100 ml (respectively) at R2 during the peak of the flood. Thus, a 250% increase was recorded with respect to initial values (start of event). In most cases, lower concentrations of bacteria were recorded in samples collected in the woodland part of the catchment – the mouth part. This is believed to be the result of dilution occurring when Ryjak stream water mixes with water supplied by its woodland tributaries.

