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# **Human Impact on the Fluvial Processes of Eurasian Rivers**

Uniwersytet Kazimierza Wielkiego

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## INFLUENCE OF KORONOWSKI RESERVOIR ON TOTAL SUSPENSION IN THE WATERS OF THE BRDA RIVER (POLAND)

ВЛИЯНИЕ КОРОНОВСКОГО ВОДОХРАНИЛИЩА НА ПЕРЕДВИЖЕНИЕ  
ВЗВЕШЕННЫХ РЕЧНЫХ НАНОСОВ В РЕКЕ БРДА

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### РЕЗЮМЕ

Создание Короновского водохранилища на реке Брда в конце 60-ых годов XX века вызвало изменения в круговращении веществ в речной экосистеме. Анализ количества общей взвеси указывает на значительное его падение в результате регуляции очистки сточных вод в бассейне реки Брда. Исследования показали также влияние Короновского водохранилища на снижение концентраций общей взвеси в водах Брды.

### Introduction

Artificial water reservoirs fulfil many functions. The most important of them are: flood control, navigation, retency, energetics, recreation, etc. All of them play significant roles in water management. Division of the Brda river in the 60's of the twentieth century and construction of a dam had influence on the circulation of matter in the whole water ecosystem. This resulted in compensation of flows on the Brda river (Jutrowska, 2007).

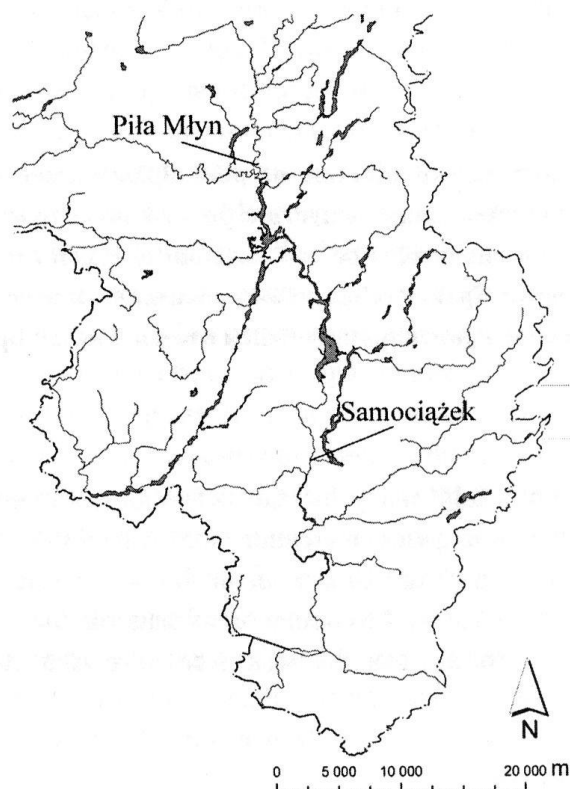
### Study area and methods

The basin area of the Brda river as a subject of analysis may be considered in relation to time and space. The spatial aspect is the total basin of the Brda river from the source (outflow from Smółowe Lake – 238.0 km) to Samociążek village (39.5 miles) located below Koronowski Reservoir. In terms of time, general load of total suspension in water was investigated in the years 1969–2009 with respect to of the environment monitoring results available at the time. The aim of the analysis was to show the impact of Koronowski Reservoir on the substance content transported in the course of the Brda river. Research methods involved the analysis of monitoring data of the Regional Inspectorate of Environment Protection in Bydgoszcz concerning the concentration of total suspended solids. Samples for laboratory analysis were taken at monthly intervals at two test and control stations.: Brda – Piła Młyn (75.1 km of the river course) and Brda – Samociążek (39.0 km of the river course) (pic. 1.). The analysis also covered total suspension from the main inflows to Koronowski Reservoir. Moreover, the data obtained from monitoring were then related to the scientific materials discussing the analyzed section of the Brda river.

The last stage of work involved spatial analysis, performed to illustrate the phenomena occurring in the environment.

### The content of total suspended solids in the waters of the Brda river

Observations carried out by the Regional Inspectorate for Environmental Protection in Bydgoszcz allowed for the analysis of concentration of total suspended solids in the waters of the Brda river above (Brda – Piła Młyn) and below (Brda – Samociażek) Koronowski Reservoir (pic. 2).



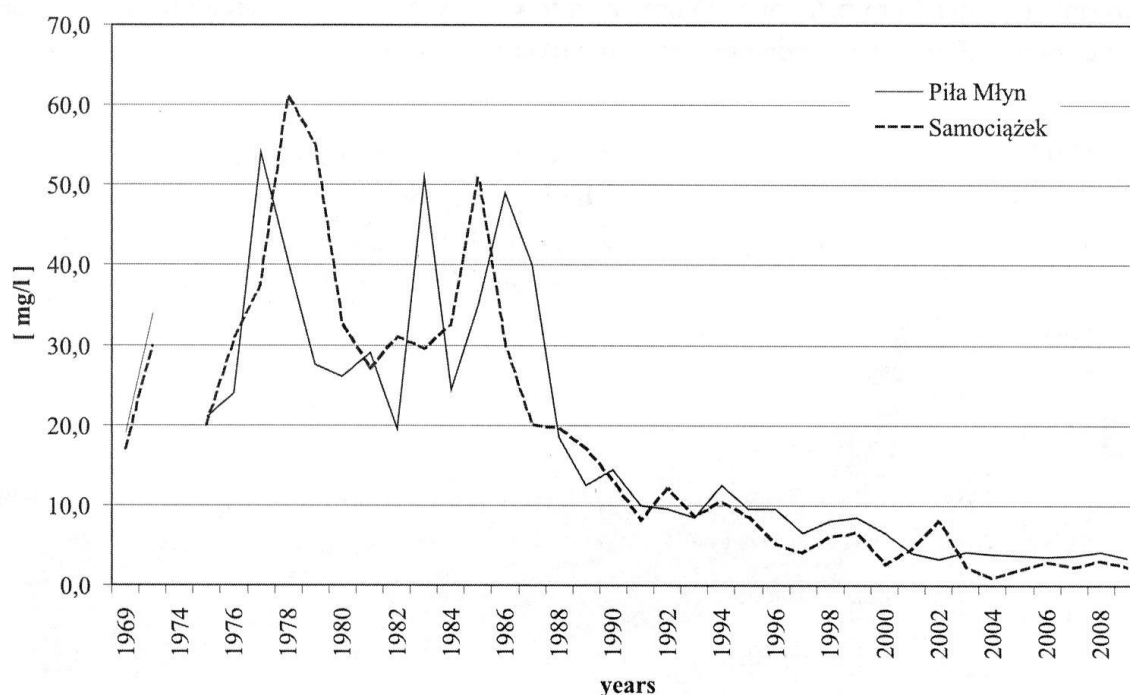
**Pic. 1.** Location of the research stations on the Brda river ( MPHP, 2007).

By the end of the 80's of the twentieth century concentration of suspended solids remained high in the waters of the Brda river on both analyzed locations. The annual values of total suspended solids oscillated from 19.5 mg/l (Brda – Piła Młyn, 1982) to 61.0 mg/l (Brda – Samociażek, 1978). After this period a significant decrease in total suspension in the waters of the Brda river was observed at both positions. Since the beginning of the 90's of the twentieth century the average value of total suspended solids has oscillated from 0.9 mg/l (Brda – Samociażek, 2004) to 14.5 mg/l (Brda – Piła Młyn, 1990).

Artificial water reservoirs cause changes in water quality. The analysis of 72 water reservoirs showed that in 42% of them the quality of water improved and 10% had reduced water quality (Woyciechowska, Dojlido, 1982). The value of total suspended solids has almost always be reduced (Dojlido, 1995).



A significant decrease of water load in total suspension in the Brda river may be associated with the regulation of wastewater disposal in the river basin. At the end of the 80's of the twentieth century the first municipal waste water treatment plants were launched. They were based on the mechanical wastewater treatment system. The strongest effect on lowering the concentration of total suspended solids in the waters of the analyzed section of the Brda river, had the launch of the mechanical treatment process in communal wastewater plant in Tuchola in 1986. Figure 3 illustrates the tendency of reduction in the amount of municipal and industrial wastewater discharged into the surface waters in Kujawsko-Pomorskie. The decrease of annual concentration of total suspended solids to less than 4.0 mg/l, which was observed in recent years, can be also associated with the systematic modernization of wastewater treatment processes.

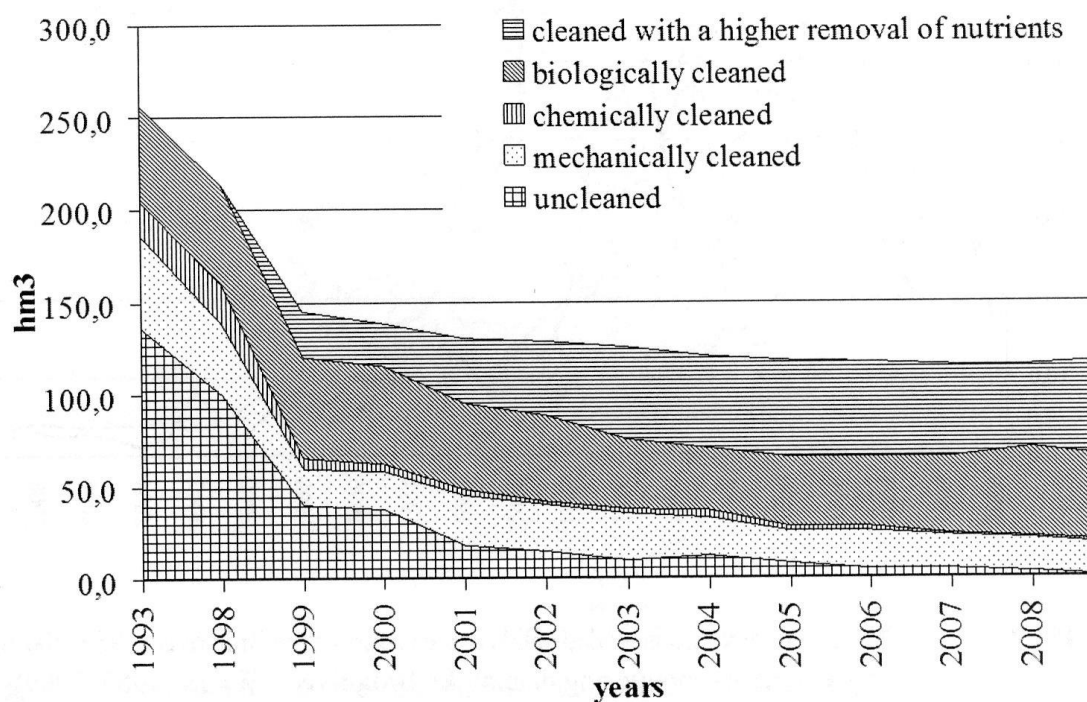


**Pic. 2.** The content of total suspended solids in the waters of the Brda river (1969–2009).  
Source: Quality monitoring data of the Brda river – WIOŚ (1969–2009).

Seasonal course of concentrations of total suspended matter in the waters of the Brda river shows regularities on both analyzed research positions (Pic. 4). There are two peaks, which strongly depend on the hydrological conditions in the basin of the Brda river. The first maximum – late spring - is associated with the increase of solids content in the Brda river waters after the spring period of high water levels. The second maximum concentration is observed in summer, when water levels are low. The Influence of Koronowski Reservoir on total suspended matter shows a seasonal course of the analyzed indicator. By the end of the 80's of the twentieth century (Pic. 1) there were no regularities. However, the analysis of the data from the last decade indicates a difference between the load of the dissolved substances in the waters above and below Koronowski Reservoir (Pic. 3). The research conducted in 1996 by Marszalewski and Jutrowska (1999) indicated that the Brda river provided the largest input of suspended solids to Koronowski Reservoir. It delivers over 78%

of sediments lifted from the catchment area. Among the other inflows of Koronowski Reservoir the largest share is provided by the Kamionka river (13.5%). Other inflows supply over 8% of the material lifted. Due to the lithologic character of the drainage area, majority of the substances delivered to Koronowski Reservoir is organic. It constitutes from 13% (Brda river) to 17% (Krówka river). The annual balance sheet of sediments lifted in Koronowski Reservoir (Marszałewski, Jutrowska 1999) based on the studies carried out in 1996 indicates that the reservoir receives 6481 tons. Accumulation in the reservoir amounts to 4,700 tonnes and 1,781 tonnes are discharged. Based on the balance sheet the silting index for Koronowski Reservoir was estimated to 72.5%.

Transport of sediments lifted in the Koronowski Reservoir basin also indicates strong human influence. An excellent example is the Kamionka river, to which once a year (in November) water from fish ponds (Kamienica town) is discharged. Then a drastic increase in the content of total suspended matter in the river waters can be observed (Pic. 5).

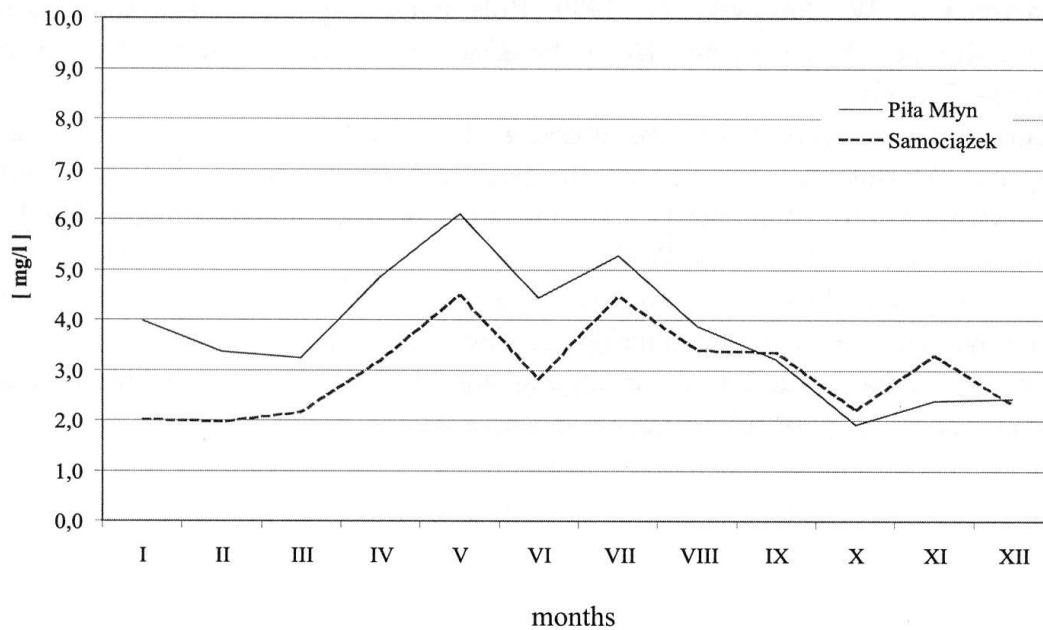


**Pic. 3.** Industrial and municipal wastewater discharged into the surface waters in the years 1993–2009 broken down by method of treatment. Source: Report on the state of the environment of Kujawsko-Pomorskie, 2010.

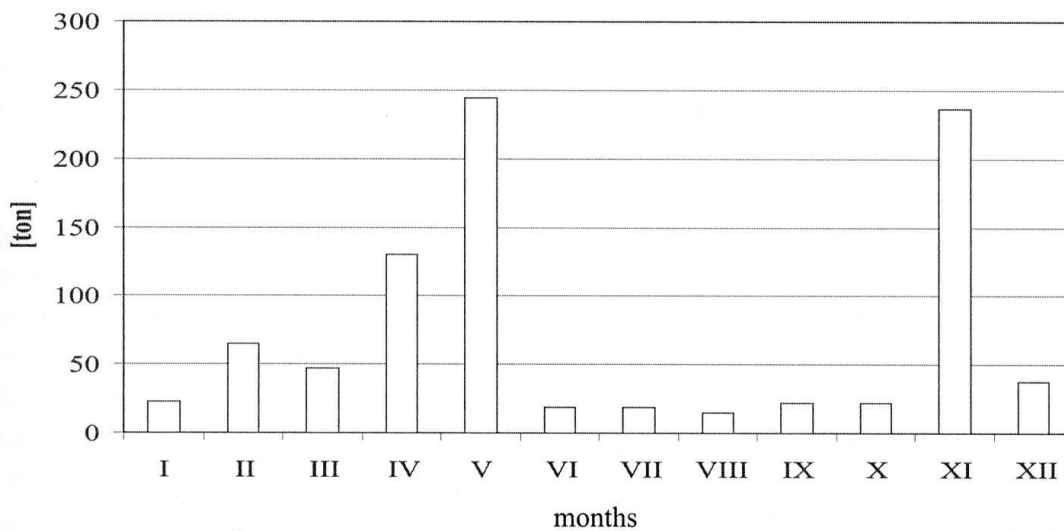
### Summary and conclusions

The presented data show a significant decrease in the concentration of total suspended matter in the waters of the Brda river in the late 80s of the twentieth century. This was caused by regulating wastewater management in the catchment. Seasonal course of concentration of total suspended matter is characterized by the presence of two peaks (late spring and summer) dependent on flow rate. Suspended substances are delivered from all the inflows of Koronowski Reservoir. Due to the lithological nature of the reservoir basin inflows it is mostly organic matter.

Because of the size of the flow rate, the main source suspensions supply to the reservoir is provided by the Brda river (78%). The analysis of the total suspended matter concentration above (Brda – Piła Młyn) and below (Brda – Samociązek) the reservoir indicates that it affects the reduction of matter concentration. 6,500 tons of suspended substances are delivered every year, 72.5% of which is accumulated. However, the annual balance sheet of the suspended sediment load strongly relates to hydrological conditions of the basin.



**Pic. 4.** Seasonal content of the total suspended matter in the waters of the Brda river (2002–2009). Source: Quality Monitoring data of the Brda river – WIOŚ (2002 – 2009).



**Pic. 5.** Seasonal course of suspension lifted in the waters of Kamionka river in 1996. Source: Marszalewski W., Jutrowska E., 1999.

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