# Reservoir management induced changes in flow regime of the Upper Narew River

Jaroslaw Napiorkowski





#### Scope of presentation

#### Introduction

• filtering out climatic and land use changes

#### Upper Narew river catchment

- Narew National Park
- Siemianowska reservoir



Two different comperative techniques to analysing the changes in flow regime for the periods before and after reservoir construction

- Eestimation of the cumulative distribution functions for low and high flow events
- Direct comparison of dimensionless characteristic values between individual stations, each of the characteristics was normalized to its average value over the entire multiannual period

Conclusions



The Narew River - the fifth river in Poland, the total length about 500 km

The area of the catchment of the Upper Narew River covers approximately 7300 km<sup>2</sup> and the study reach is about 110 km long.



## **Upper Narew River**

- The river is not channelized
- The valley is about 1-2 km wide and 7 10 m deep, it was shaped by a meandering river channel and presents a natural form of lowland river systems with relatively small slope values.
- Nearly 90% of the valley is occupied by reach wetland ecosystems, mostly by marshes (55%) and peat lands (31%), remaining 10% is covered by postglacial mineral soils and sand dunes











### Hydrological and hydro-technical situation

Serious influence of the Siemianówka Reservoir on water quality and quantity along whole upper Narew River.

#### Characteristics of the Siemianówka Reservoir

Maximal storage capacity Maximal outflow Minimum flow Reservoir maximal length Reservoir maximal width Reservoir mean depth

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79.5 mln m<sup>3</sup> 145 m<sup>3</sup>/s 2.1 m<sup>3</sup>/s 10 km 4 km 2.5 m



# Three catchments were selected for the analysis.

 Narew catchment - affected by the reservoir (1951-2020);
Narewka catchment up to the Narewka profile (1951-2020)
Supraśl catchment up to the Gródek profile (1975-2020)

(2) and (3) are in close geographical proximity & are not affected by the reservoir.











In the first approach, as part of the statistical analysis of flows, for daily flows in **Suraż, Narewka & Grodek,** the cumulative distribution functions were estimated for

**low flows** (below the 0.25 quantile) and **high flows** (above the 0.75 quantile),

for two periods, **before and after** the construction of the Siemianówka reservoir.



## Pre-Siem 1951-1987; Post-Siem 1990-2020

Station	Suraz		Narewka		Grodek	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
	Siem	Siem	Siem	Siem	Siem	Siem
min value	1.52	1.85	0.30	0.23	0.12	0.04
0.25 quantile	5.60	6.64	1.09	0.96	0.46	0.31
median	9.55	10.20	1.80	1.62	0.71	0.57
0.75 quantile	18.20	18.90	3.55	3.14	1.15	0.98
mean	15.43	14.09	3.19	2.55	1.02	0.81
max value	250.00	169.00	50.70	43.10	25.10	14.00











In the second approach, based on the sequences of flows in three analyzed stations for the hydrological years 1951-2020 (S & N) and 1976-2020 (G), the sequences of four hydrological characteristics were calculated:

- the minimum annual flows,
- the mean annual flows,
- the maximum annual flows and
- standard deviations of flows during the year.

In order to enable direct comparison of dimensionless values between individual stations, each of the characteristics was normalized to its average value over the entire multiannual period.

Moreover, the differences between the normalized characteristics for Suraz and Gródek, and differences between the normalized characteristics for Suraż and Narewka were calculated.



#### the operation of the reservoir has influence on low flows









#### the operation of the reservoir has no influence on high flows









# Conclusions

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- The cumulative distribution functions of low flow events (below the 0.25 quantile) show the changes in low flow values for Suraz (Upper Narew) pre- and post- the building of the reservoir. This result supports evidence of the influence of Siemianówka on low flows in the main course of the Upper Narew River.
- the approach, based on normalized characteristics in three analysed stations, show the similar changes in minimum flow values for Suraz
- The high flow event cumulative distribution function (above the 0.75 quantile) for Suraz (Upper Narew) and Narewka both show a slight decrease in the number of medium-high flow peaks.
- As the reservoir management aims to decrease the highest flow peaks, this result does not contradict the reservoir's activity,