



Pan-Eurasian Experiment

PEEX

INAR
INSTITUTE FOR ATMOSPHERIC AND
EARTH SYSTEM RESEARCH

**PEEX (Pan-Eurasian EXperiment programme) Online
Seminar**

9 April 2026

**PERSISTENT LOW-WATER PHASE OF
MAJOR UKRAINIAN RIVERS
FLOWING INTO THE NORTH-
WESTERN BLACK SEA UNDER
ONGOING CLIMATE CHANGE**



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- ▶ The northwestern part of the Black Sea (NWBS) within Ukraine includes the mouths of its largest rivers—the **Dnipro, Southern Buh, Dniester, and Danube**.
- ▶ The inflow of fresh surface water from these rivers significantly affects the hydrological and chemical regimes of transitional and marine waters in the study area.
- ▶ In recent years, climate change and increasing anthropogenic pressure have led to substantial changes in river runoff in southern Ukraine.
- ▶ The **objective of this study** is to analyze the water discharge trends of recent decades to identify current changes in the volume of water flow from major rivers entering the Black Sea within the NWBS, which significantly influence the spatial and temporal variability of temperature, salinity, and the thermohaline structure of the waters.

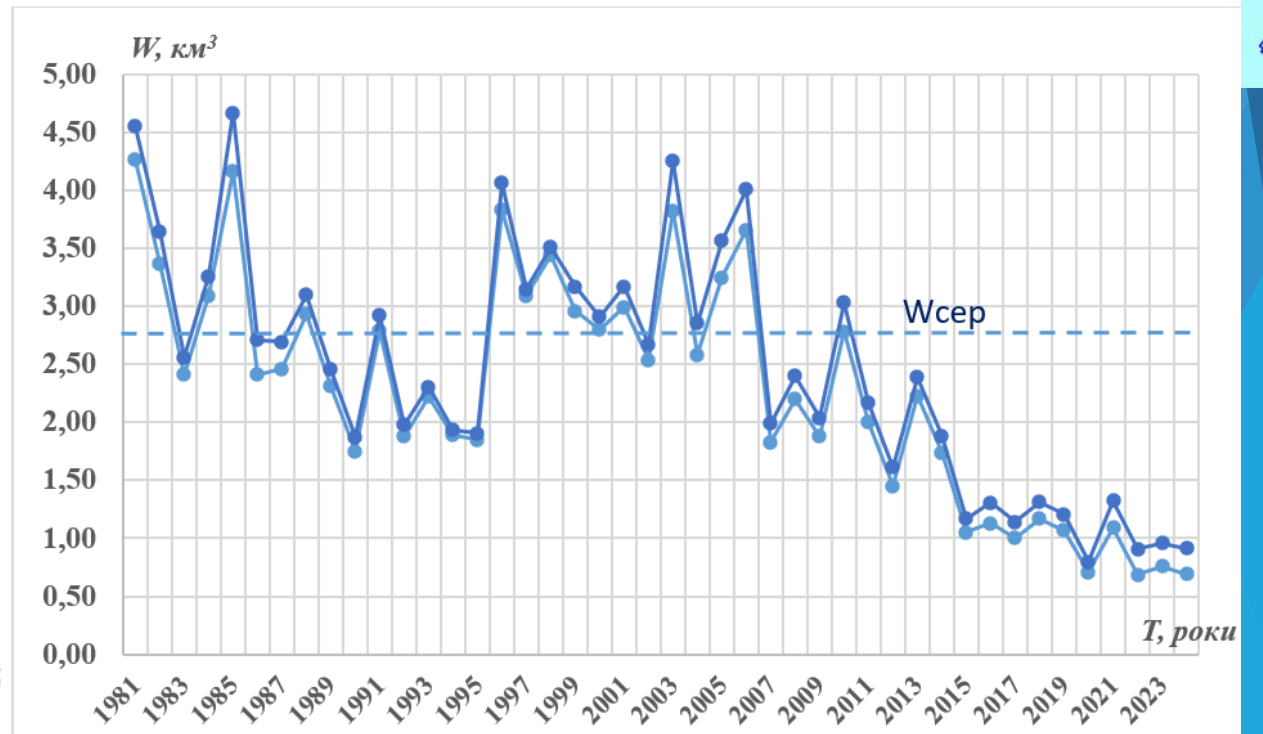
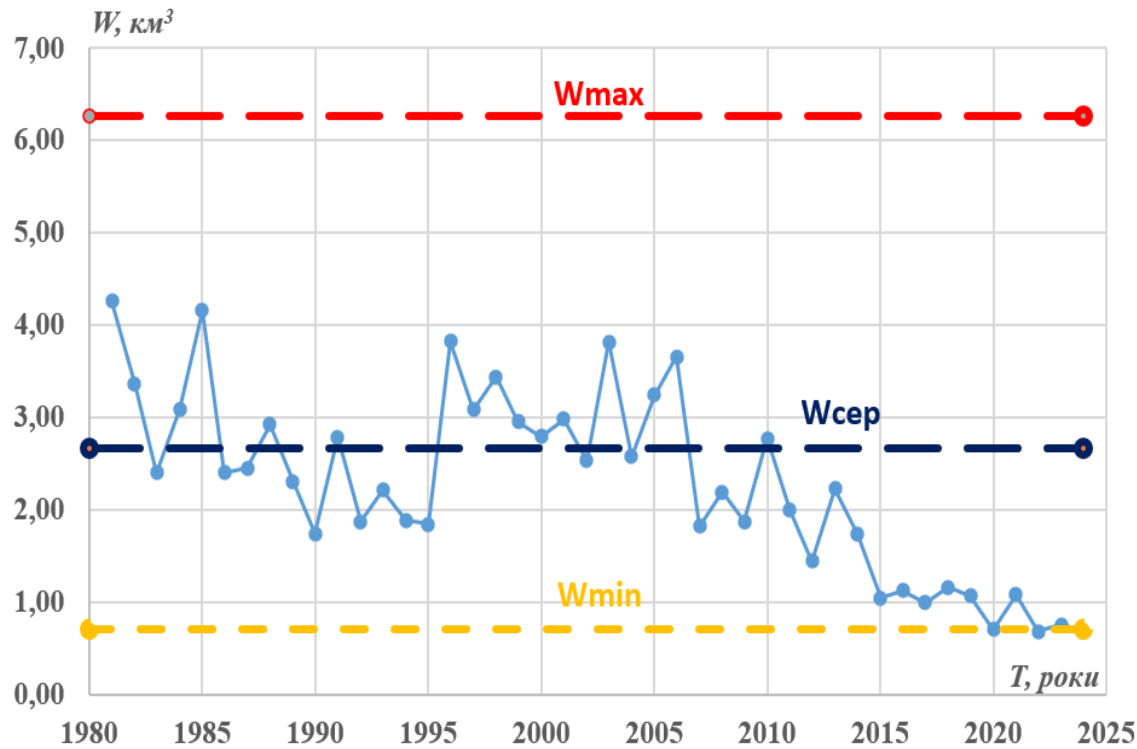
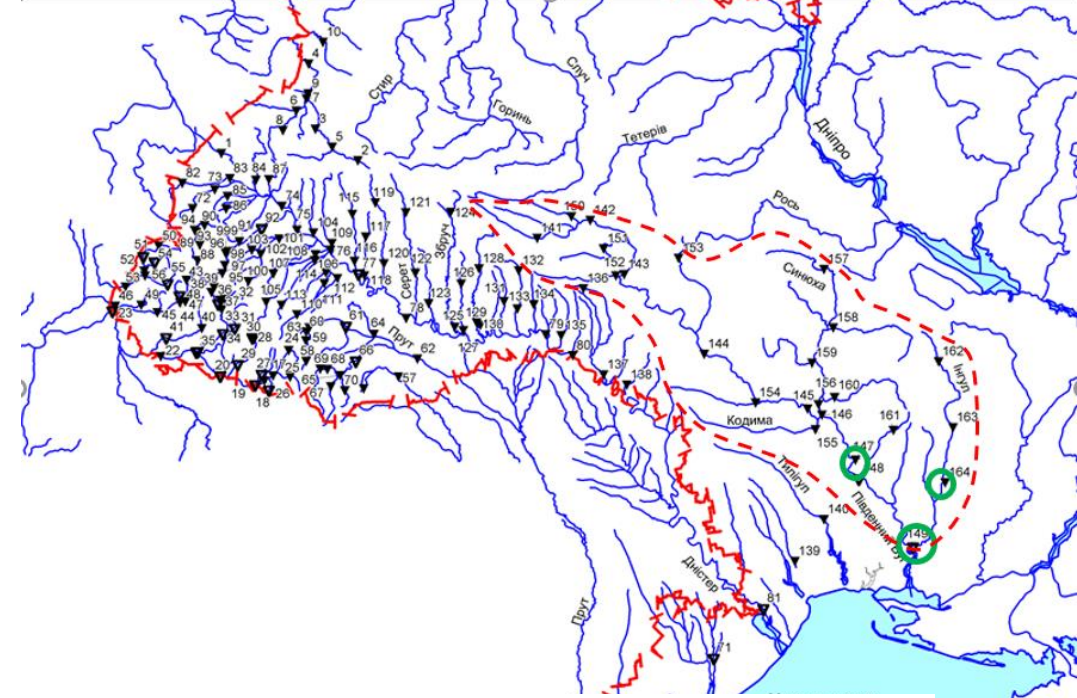


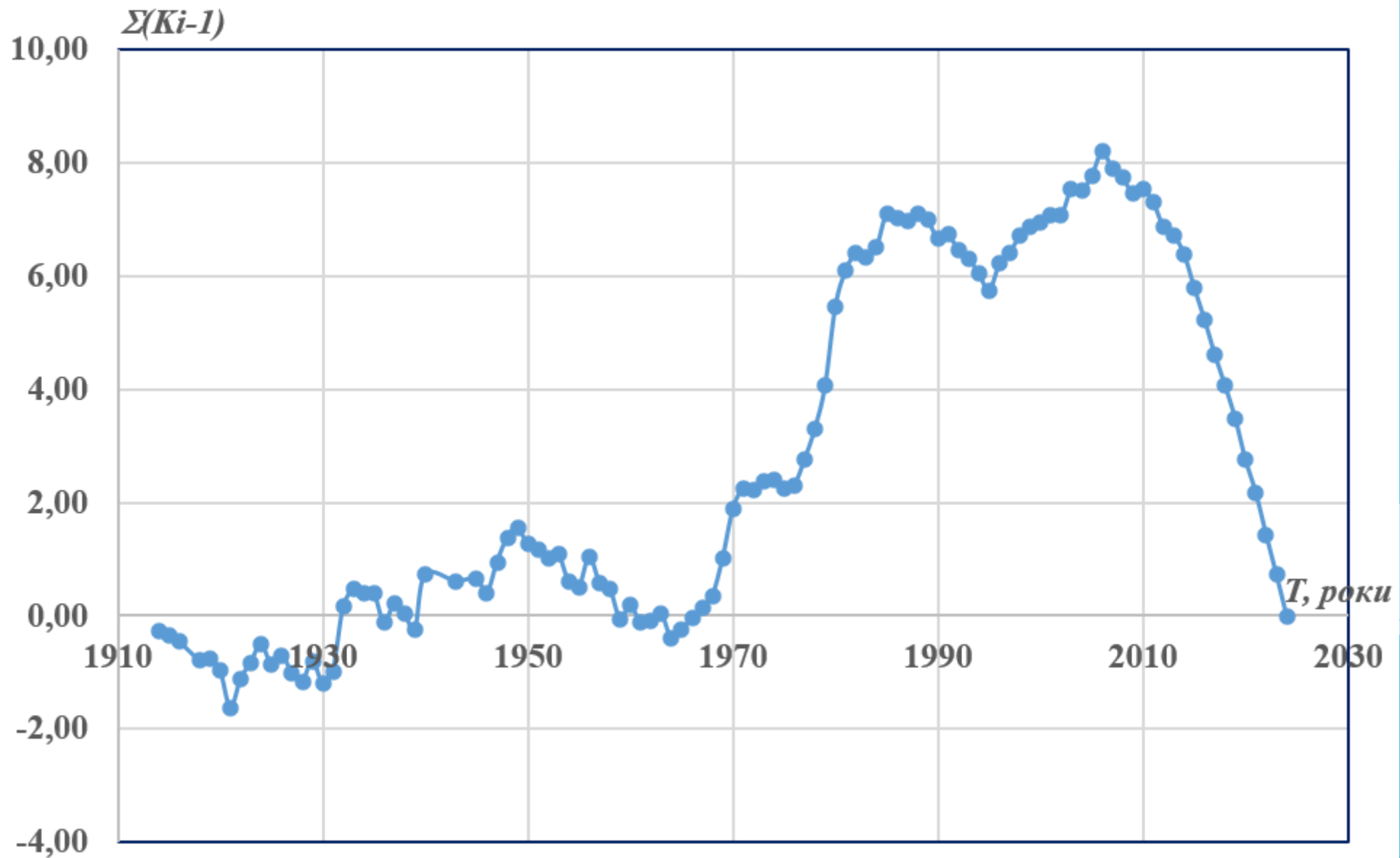
- ▶ To achieve this objective, archival data stored in the **Research and Educational Laboratory of Hydrological Information and Calculations at the Department of Land Hydrology, Faculty of Hydrometeorology and Environmental Science, Odessa National University**, were used.
- ▶ The study was conducted within the framework of the project funded by the Ministry of Education and Science of Ukraine—"Advanced Automated Modeling Complex for Diagnosis and Forecast of Oceanographic Characteristics in the Ukrainian Part of the Azov-Black Sea Basin Water Area and Results of Its Application in Test Mode", **under the supervision of Prof. Y.S. Tuchkovenko**.
- ▶ The study analyzes the water discharge dynamics of the largest Ukrainian rivers discharging into the Black Sea over the past four decades (1981-2021), along with the latest available data up to December 2024.



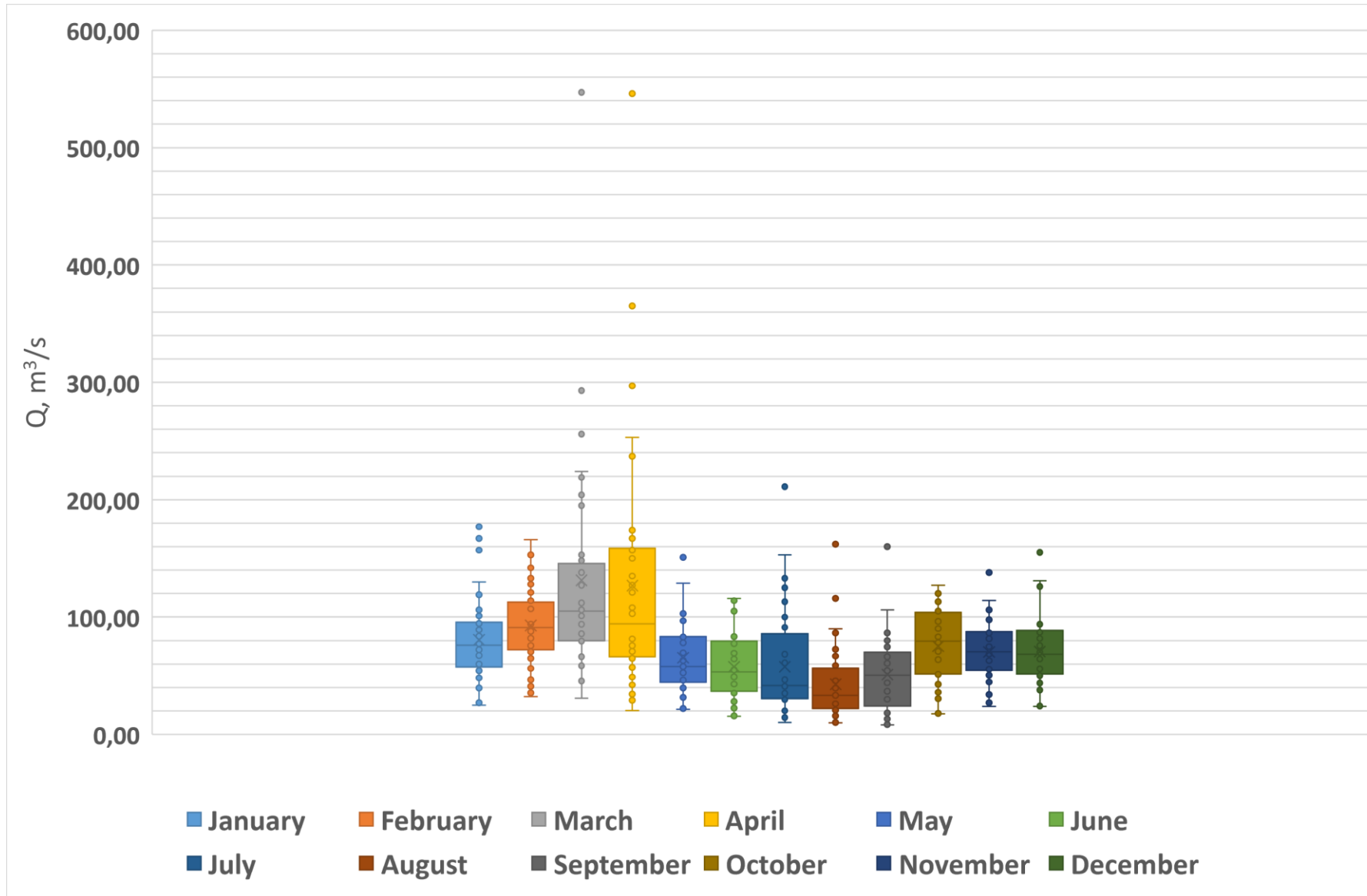
Southern Buh

- ▶ The analysis of Southern Buh's water discharge indicates a sharp decline since 2010, reaching a historical minimum in 2020. According to real-time data from the ARM-Hydro resource, this decreasing trend continues to the present

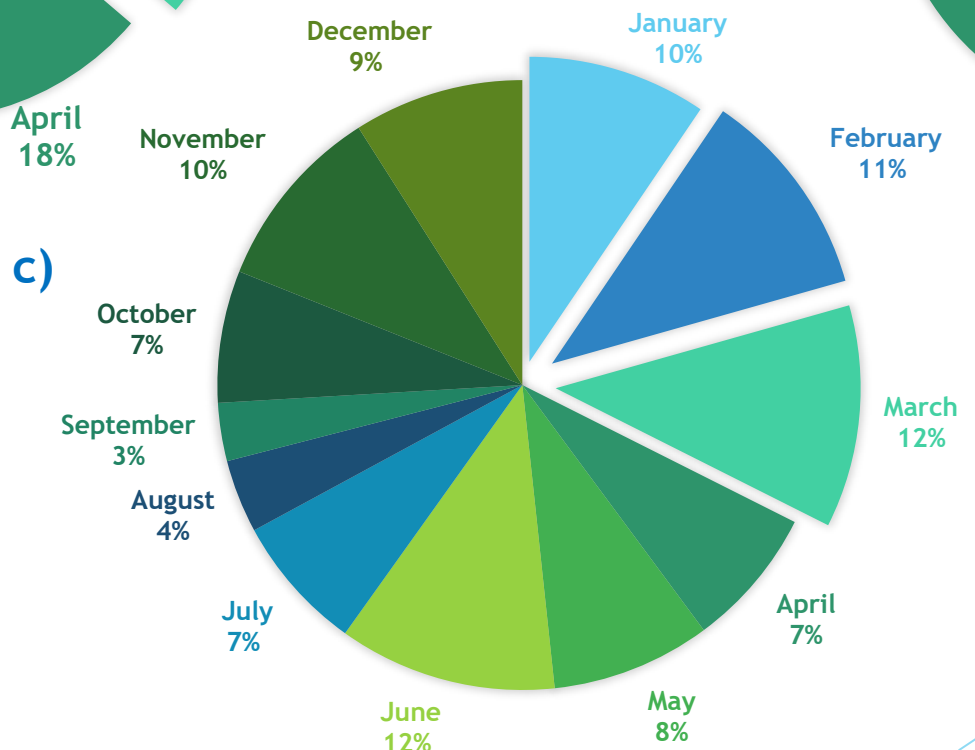
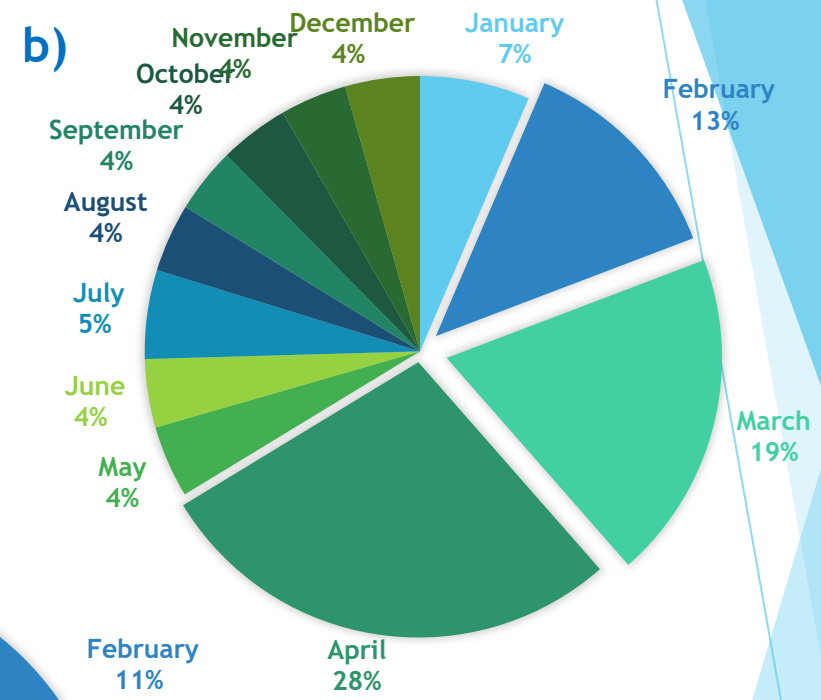
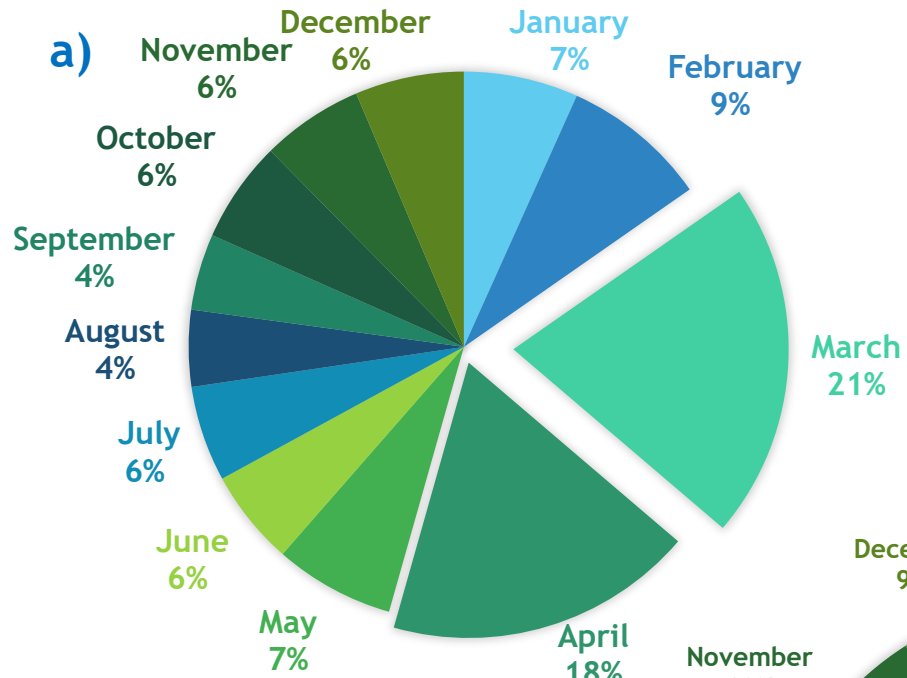




Intra-annual variation of mean monthly water discharge of the Southern Buh River at Oleksandrivka (1981-2020)



Typical runoff volume distribution (in %) of the Southern Bug River at Oleksandrivka settlement: a) average-water year, b) high-water year, c) low-water year

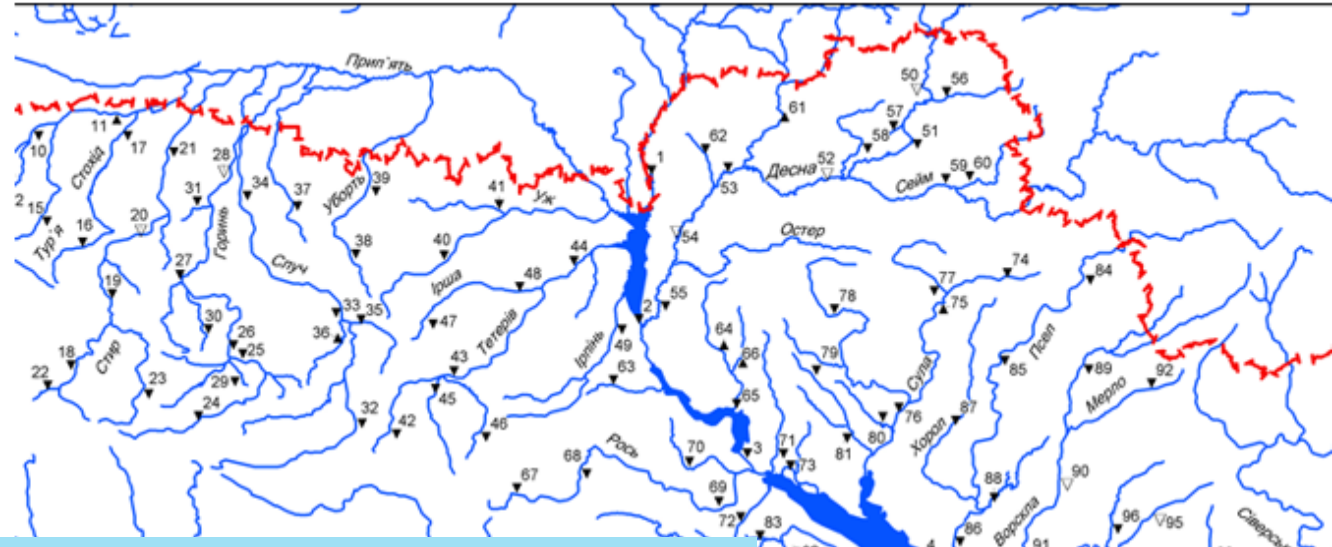


Typical intra-annual runoff distribution of the Southern Bug River - Oleksandrivka settlement for years with different water availability

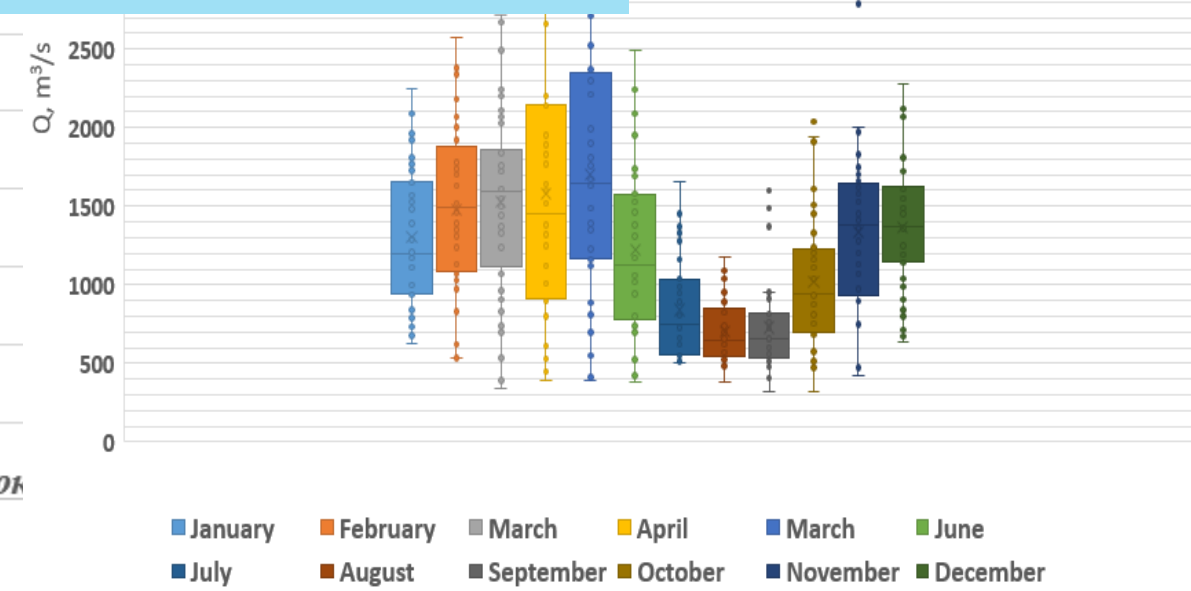
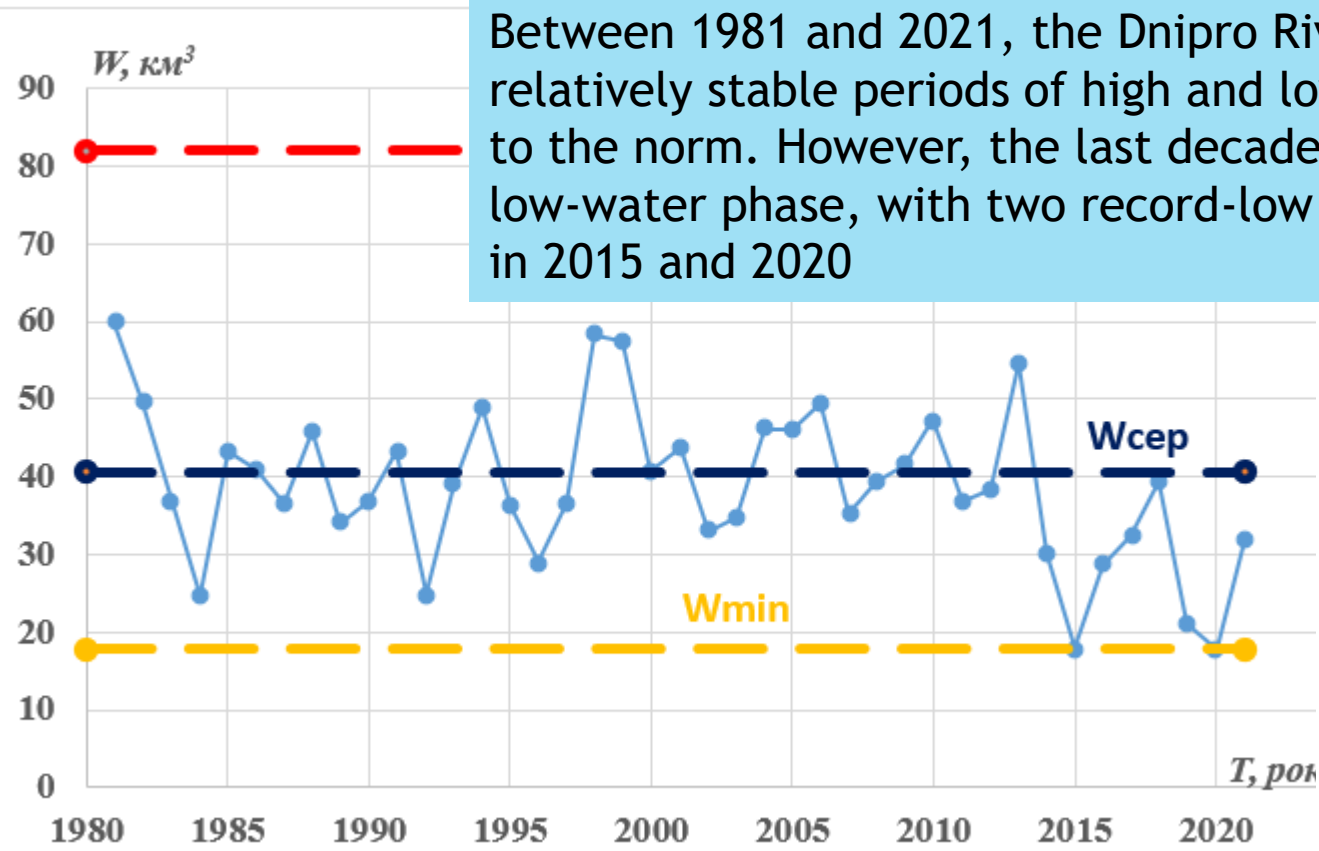
Mean monthly runoff volume, km ³												
01	02	03	04	05	06	07	08	09	10	11	12	Рік
Extremely wet year (1980)												
0,70	1,38	2,09	3,01	0,46	0,44	0,57	0,43	0,41	0,44	0,43	0,47	6,24
High-water year (1981)												
0,42	0,40	0,69	0,41	0,35	0,22	0,27	0,18	0,22	0,33	0,36	0,42	4,26
Average-water year (2010)												
0,27	0,31	0,37	0,28	0,13	0,23	0,27	0,08	0,10	0,24	0,23	0,26	2,78
Low-water year (2020)												
0,07	0,08	0,08	0,05	0,06	0,08	0,05	0,03	0,02	0,05	0,07	0,06	0,71

Dnipro River

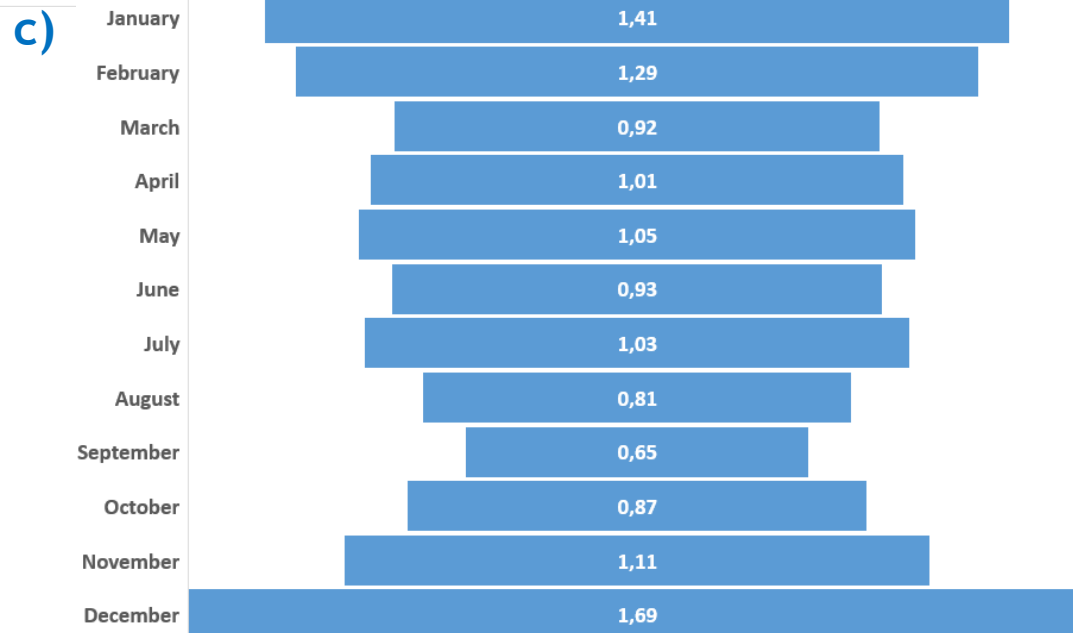
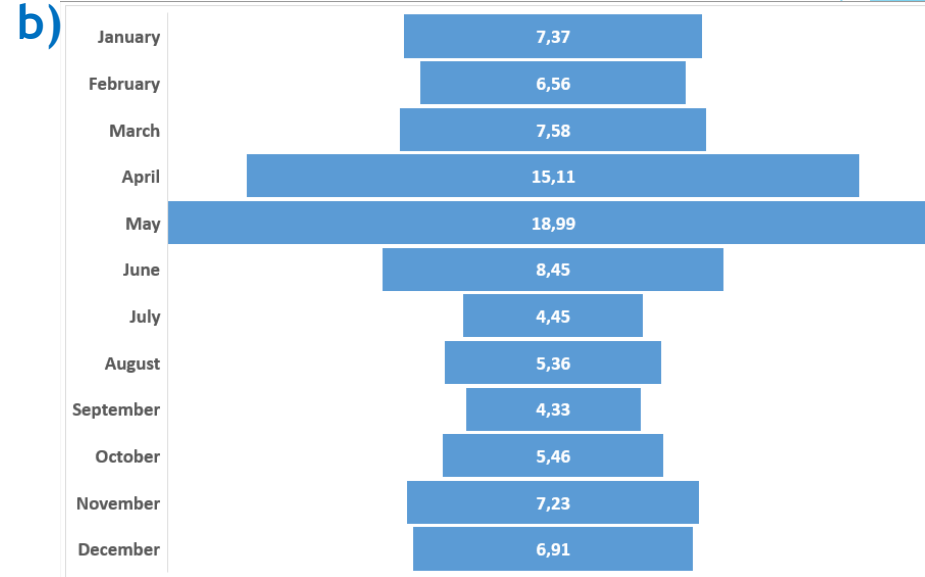
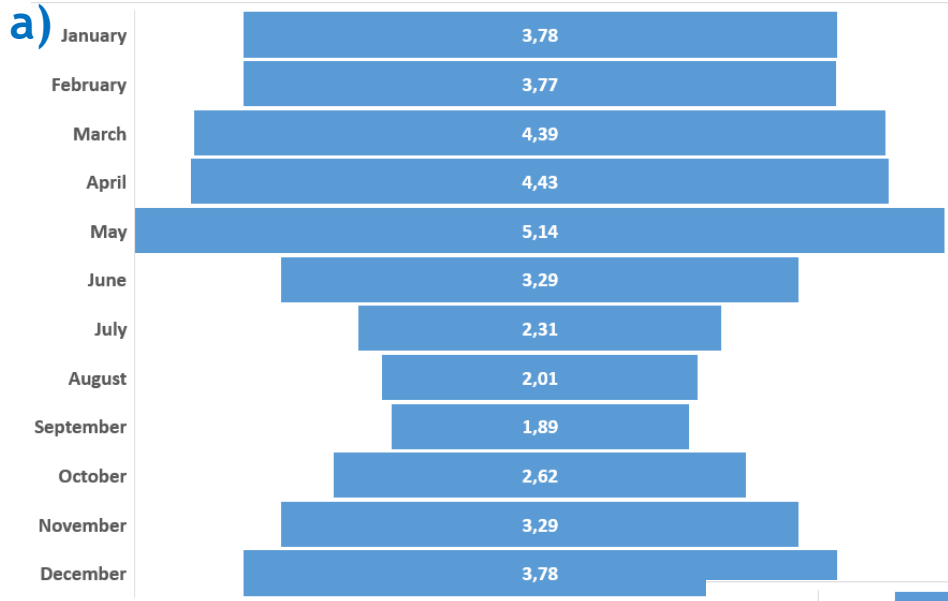
In this study, long-term observation data from the hydrological stations on the Dnipro River at the Kakhovka HPP and in the city of Kherson were used to assess the variability and volumes of water runoff in the lower part of the Dnipro.



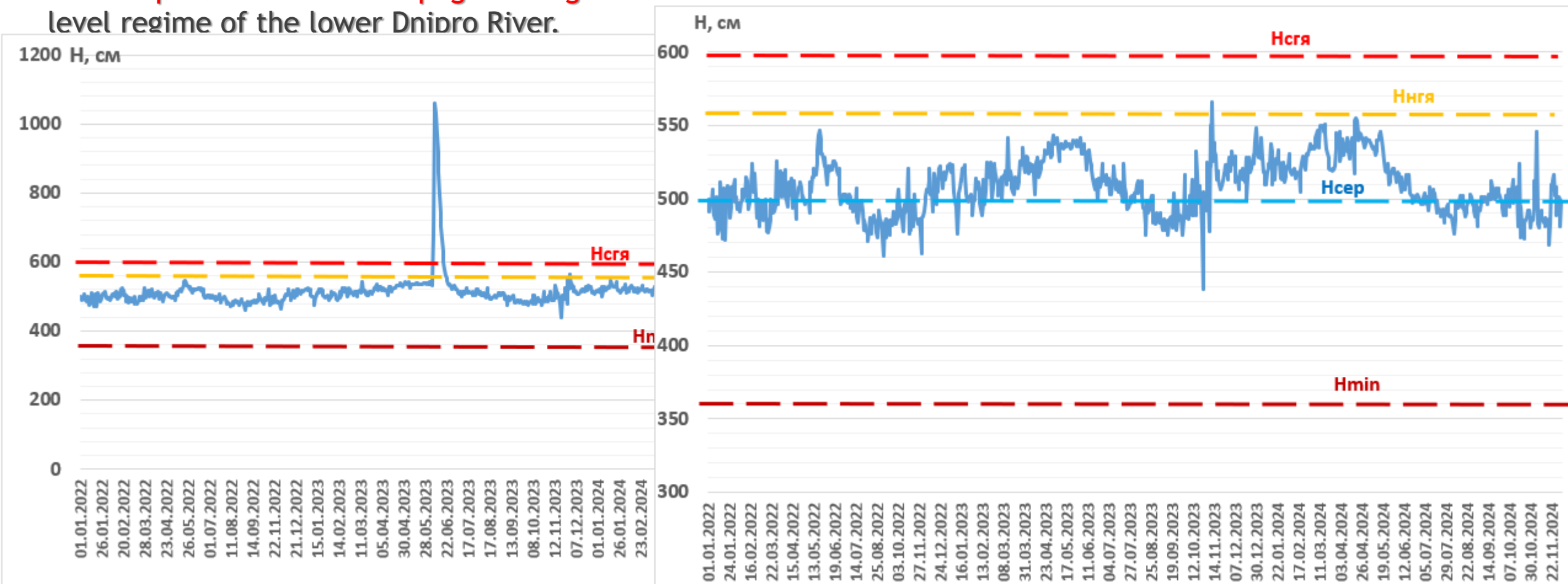
Between 1981 and 2021, the Dnipro River's discharge exhibited relatively stable periods of high and low water levels compared to the norm. However, the last decade has shown a prolonged low-water phase, with two record-low discharge values observed in 2015 and 2020



Typical runoff volume distribution (in %) of the Dnipro River at the Kakhovka HPP nt: a) average-water year, b) high-water year, c) low-water year



▶ Using the current hydrometeorological data from the ARM-Hydro resource, the water level regime at the Dnipro River - Kherson station for the years 2021-2024 can be analyzed. Figures show the chronological water-level trend from January 1, 2021, to December 23, 2024, at the Dnipro River - Kherson station. The graph clearly illustrates a significant spike in water levels in June 2023 following the destruction of the Kakhovka Hydroelectric Station dam, reaching **1059 cm on June 8, 2023**, compared to the maximum observed level of 665 cm in 1970. However, this case is an example of a **catastrophic flood of anthropogenic origin** and does not characterize the natural water level regime of the lower Dnipro River.



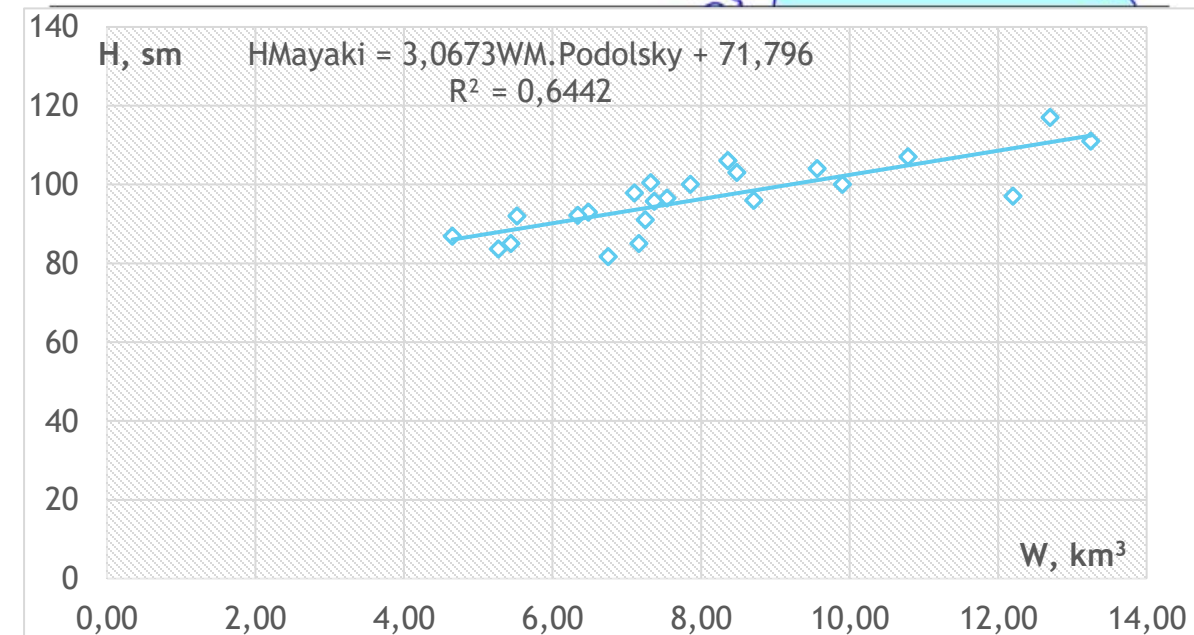
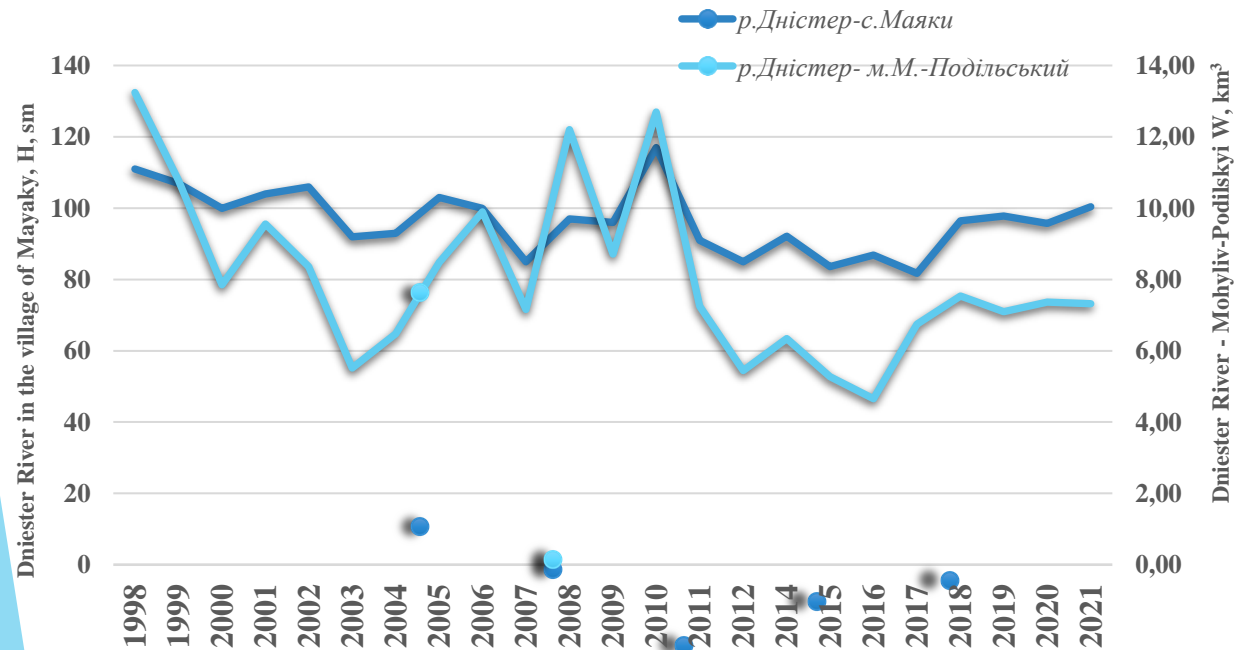
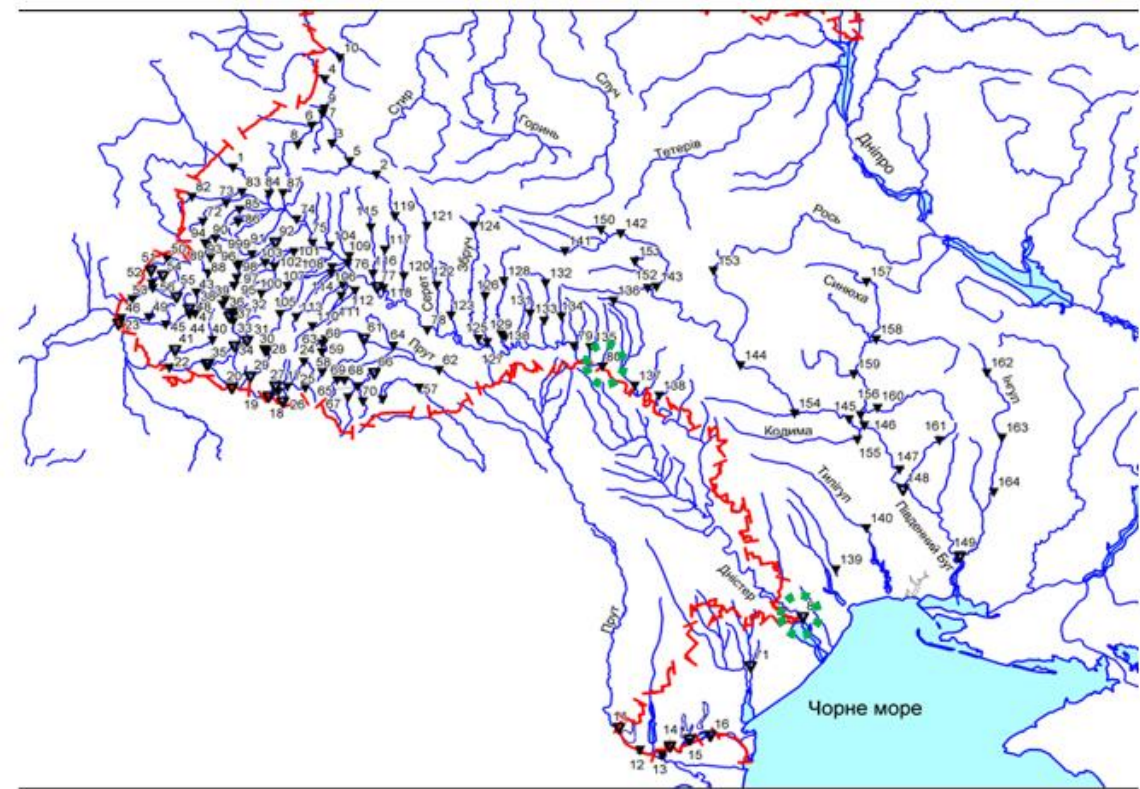
Odessa Black Sea coast after dam collapse

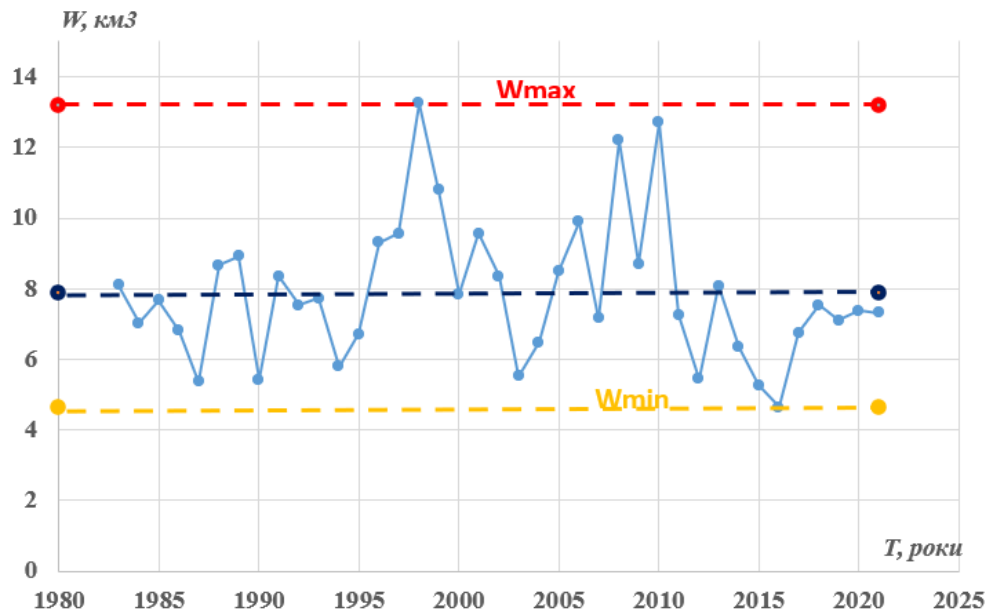


Processed color satellite images of the surface of the northwestern Black Sea illustrating the spread of polluted turbid waters from the Dnipro-Bug Estuary

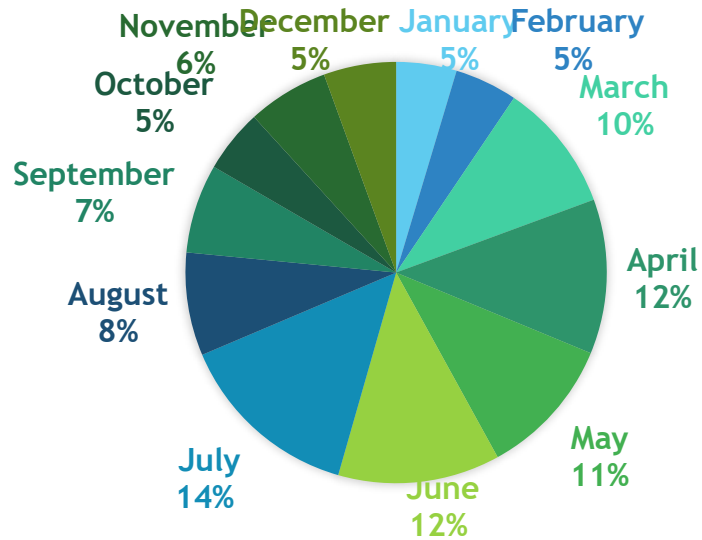
Dniestr River

The diagram of the location of hydrological stations illustrates well the key geographical unevenness in data collection across the Dniester River basin. Most of the stations are concentrated in the upper Carpathian and middle Podolian parts, providing more accurate data on water levels in these areas. However, in the lower Black Sea part, there is only one station, the Dniester River in the village of Mayaki, where long-term water level observations are conducted. The nearest station measuring water discharge is located in the city of Mohyliv-Podilskyi.

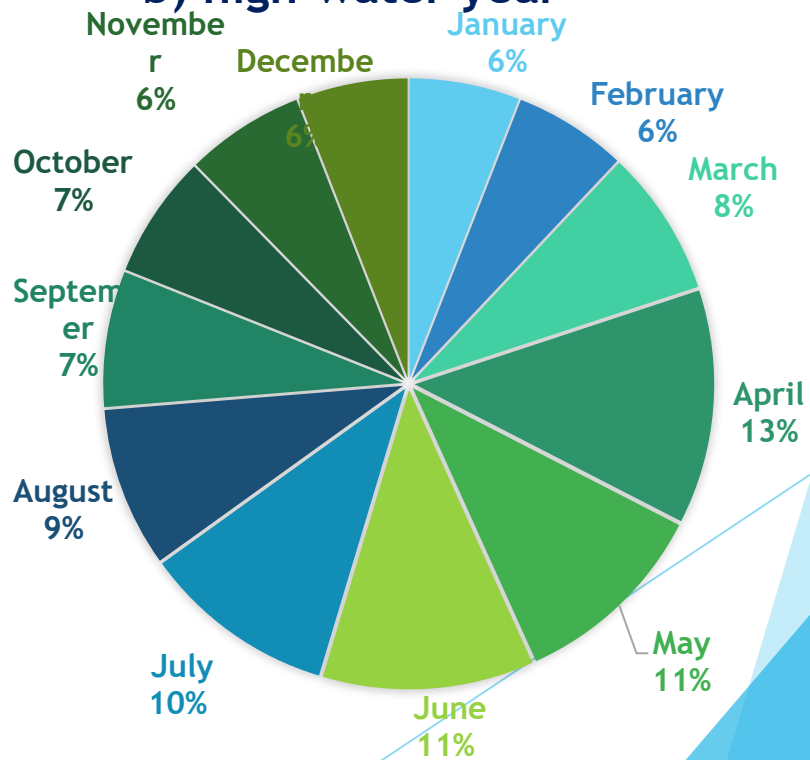




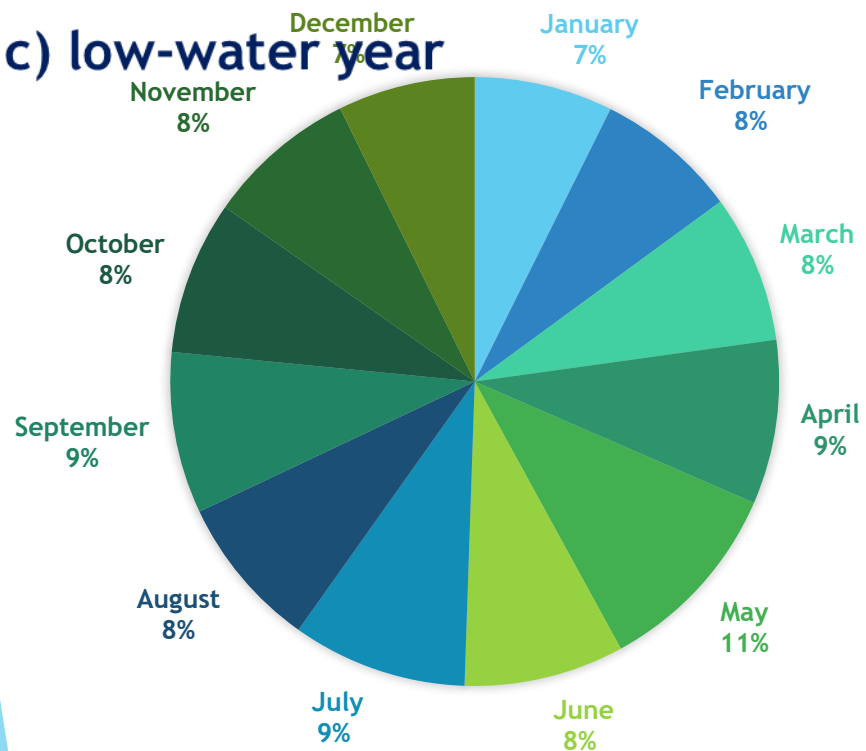
a) average-water year



b) high-water year



c) low-water year

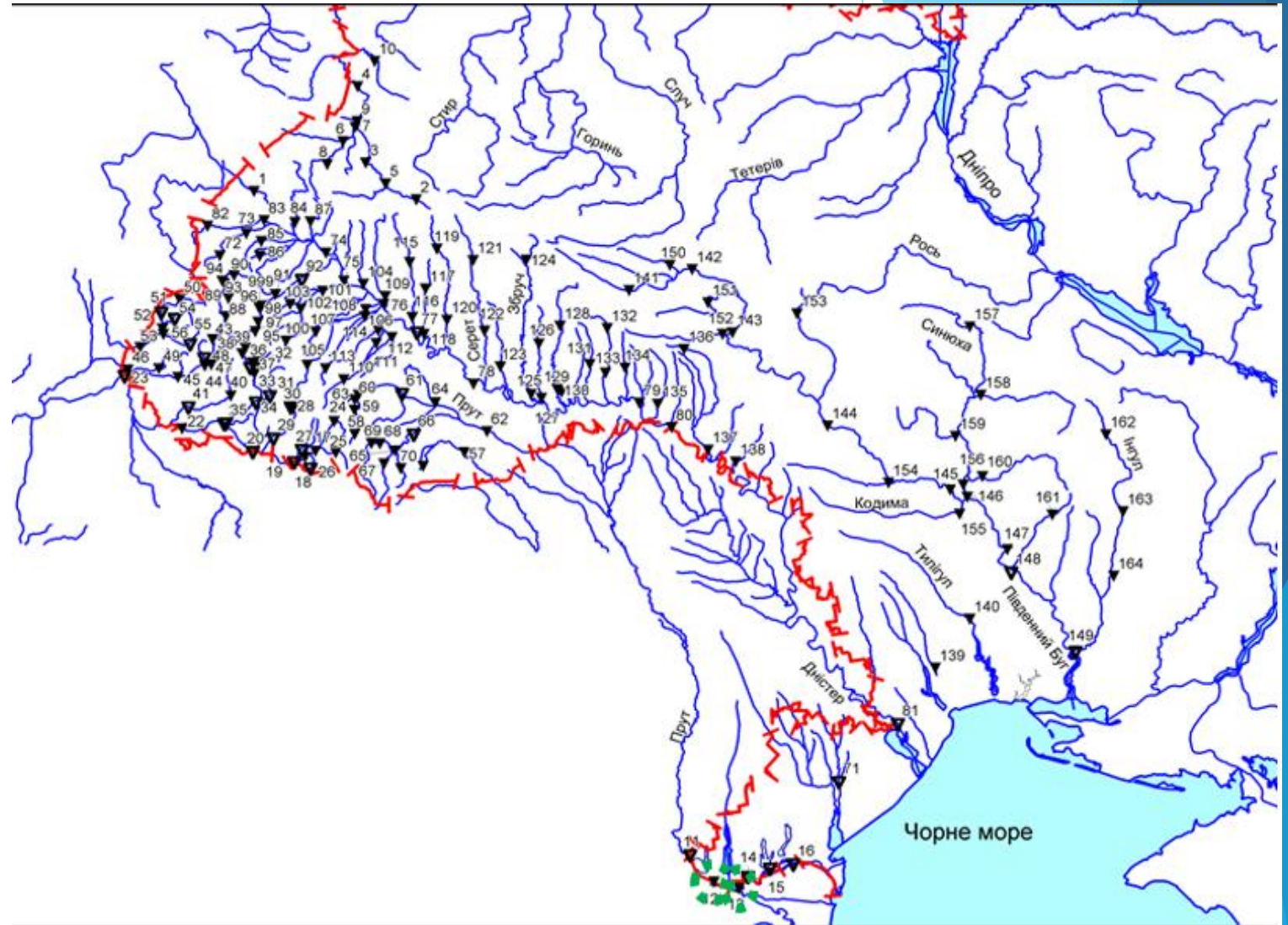


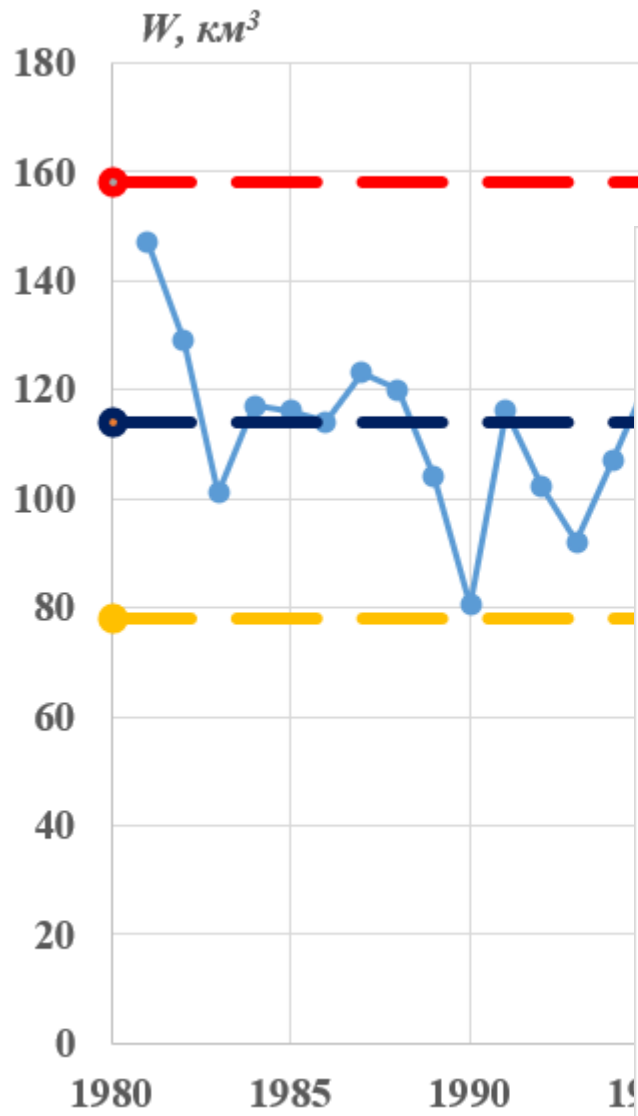
Typical intra-annual runoff distribution of the Dniester River-city Mohyliv-Podilskyi for years with different water availability

Mean monthly runoff volume, km ³ /%												
01	02	03	04	05	06	07	08	09	10	11	12	Pik
High-water year (1981)												
0,68	0,60	0,61	1,30	1,37	2,24	2,23	0,83	0,58	0,95	1,30	0,57	13,25
5,1	4,6	4,6	9,8	10,3	16,9	16,8	6,3	4,3	7,2	9,8	4,3	100
Average-water year (2000)												
0,55	0,75	0,71	1,74	0,84	0,46	0,59	0,49	0,38	0,46	0,43	0,42	7,85
7,0	9,6	9,1	22,1	10,7	5,9	7,5	6,2	4,9	5,8	5,4	5,4	100
Low-water year (2016)												
0,31	0,28	0,29	0,52	0,39	0,37	0,39	0,44	0,39	0,37	0,40	0,46	4,65
6,6	5,9	6,3	11,2	8,5	8,0	8,4	9,6	8,4	8,1	8,6	9,9	100

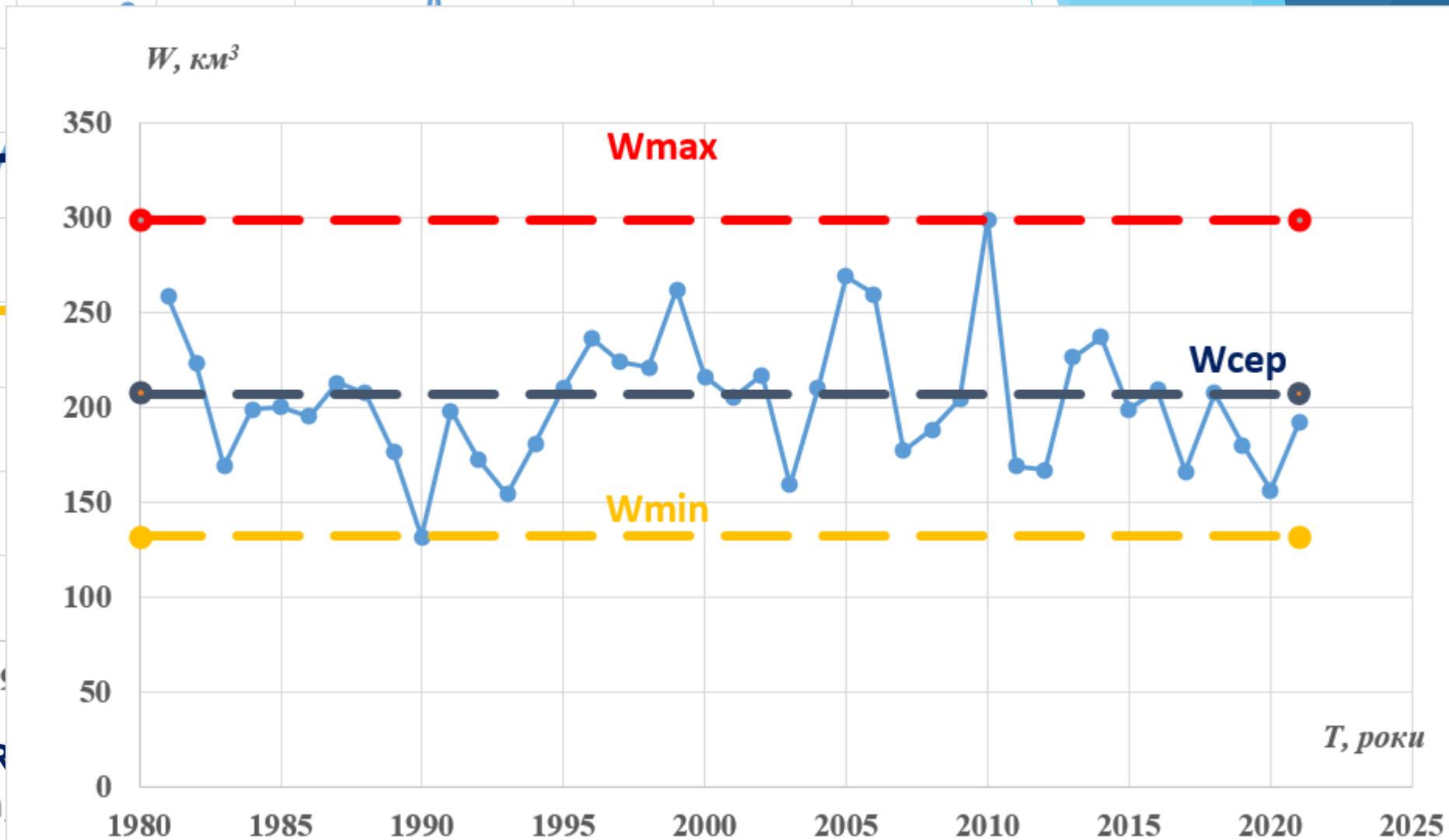
Danube

- ▶ For the analysis of the runoff in the lower part of the Danube over the last decades, data from the State Water Cadastre of Ukraine for the years 2016-2020 and the entire observation period have been used, along with current hydrological information from the ARM-Hydro resource provided by the Ukrainian Hydrometeorological Center (UkrGMC). Since the catchment areas of the hydrological stations on the Danube River at the city of Reni (hydrostation, 54 miles) and at the Kiliya Mouth of the Danube River at the city of Izmail (hydrostation, 115 km) differ by 2000 km², but this difference is not significant in terms of the total area, it is therefore reasonable to analyze the runoff at both stations.





Kiliya Mouth of the Danube River (hydrostation, 54 miles)



Danube River at the city of Reni (hydrostation, 54 miles)

Typical intra-annual runoff distribution of the Danube River at the city of Reni (hydrostation, 54 miles) for years with different water availability

Mean monthly runoff volume, km³

01	02	03	04	05	06	07	08	09	10	11	12	Pik
High-water year (2010)												
27,9	17,8	31,9	27,2	25,0	34,2	33,2	21,6	17,2	18,8	16,1	28,7	299
Average-water year (2016)												
12,1	16,8	30,8	21,0	21,5	21,7	18,1	14,7	10,8	11,0	16,1	13,3	209
Low-water year (1990)												
11,8	10,0	13,8	12,4	13,4	11,7	11,5	6,8	6,0	8,0	10,9	16,0	132

Conclusions

- The study presents an analysis of the water flow of the largest rivers of Ukraine that discharge their waters into the Black Sea over the last decades from 1981 to 2021, as well as an analysis of the available current data up to December 2024.
- The analysis of the **Southern Bug River's** flow revealed a sharp decrease in water discharge starting from 2010, reaching a minimum for the entire observation period in 2020. Using current data from the ARM-Hydro resource, it is shown that the trend of significant reduction continues to this day.
- From 1981 to 2021, the water flow of the **Dnieper River** is characterized by relatively uniform periods of high and low water flow, compared to the norm. However, the last decade stands out with a more prolonged low-water phase, during which the flow volumes reached their minimum values twice— in 2015 and 2020.
- The fluctuations in the flow of the **Dniester River** over the last 40 years have a cyclical nature, with high-water and low-water periods alternating relatively evenly. However, in the last 10 years, the flow has been characterized by low-water conditions, which is also observed in the Dnieper and Southern Bug rivers.

Conclusions

- ▶ The analysis of the flow dynamics in the delta section of the **Danube** on the territory of Ukraine shows that during the period from 1983 to 1994, a low-water phase was observed, followed by a high-water phase from 1995 to 2002. In the following years, until 2015, low-water and high-water years alternated with a periodicity of 2-3 years, after which, starting in 2016, a low-water phase has continued to the present.
- ▶ The study indicates that **all major Ukrainian rivers** are currently experiencing a prolonged low-water phase, with varying onset times and durations. However, the past decade has been characterized by consistently **low water** levels across all analyzed rivers. The situation is **particularly critical for the Southern Buh**, where discharge has reached historical minimum values in the entire period of instrumental observations.
- ▶ Given these results and the projected climate change scenarios outlined by the Intergovernmental Panel on Climate Change (IPCC), it is recommended to use a typical low-water year distribution when modeling the current hydrological conditions of the Dnipro, Southern Buh, Dniester, and Danube Rivers.

Further Research and Project Framework

- ▶ This research is being further developed within the framework of the project:
- ▶ “Sustainable development of water resources management and modeling in the Northwestern Black Sea region under increasing climate extremes and anthropogenic pressure.” (2026-2028) funded by the Ministry of Education and Science of Ukraine
- ▶ The study is also aligned with the activities of the **Pan-Eurasian Experiment (PEEX) programme**, which promotes interdisciplinary research on climate change, environmental processes, and sustainability across Northern Eurasia.
- ▶ Within this framework, our work contributes to:
 - understanding hydrological responses to climate change
 - improving regional environmental monitoring and modeling
 - supporting science-based decision-making for sustainable water management



Thank you for your attention!

