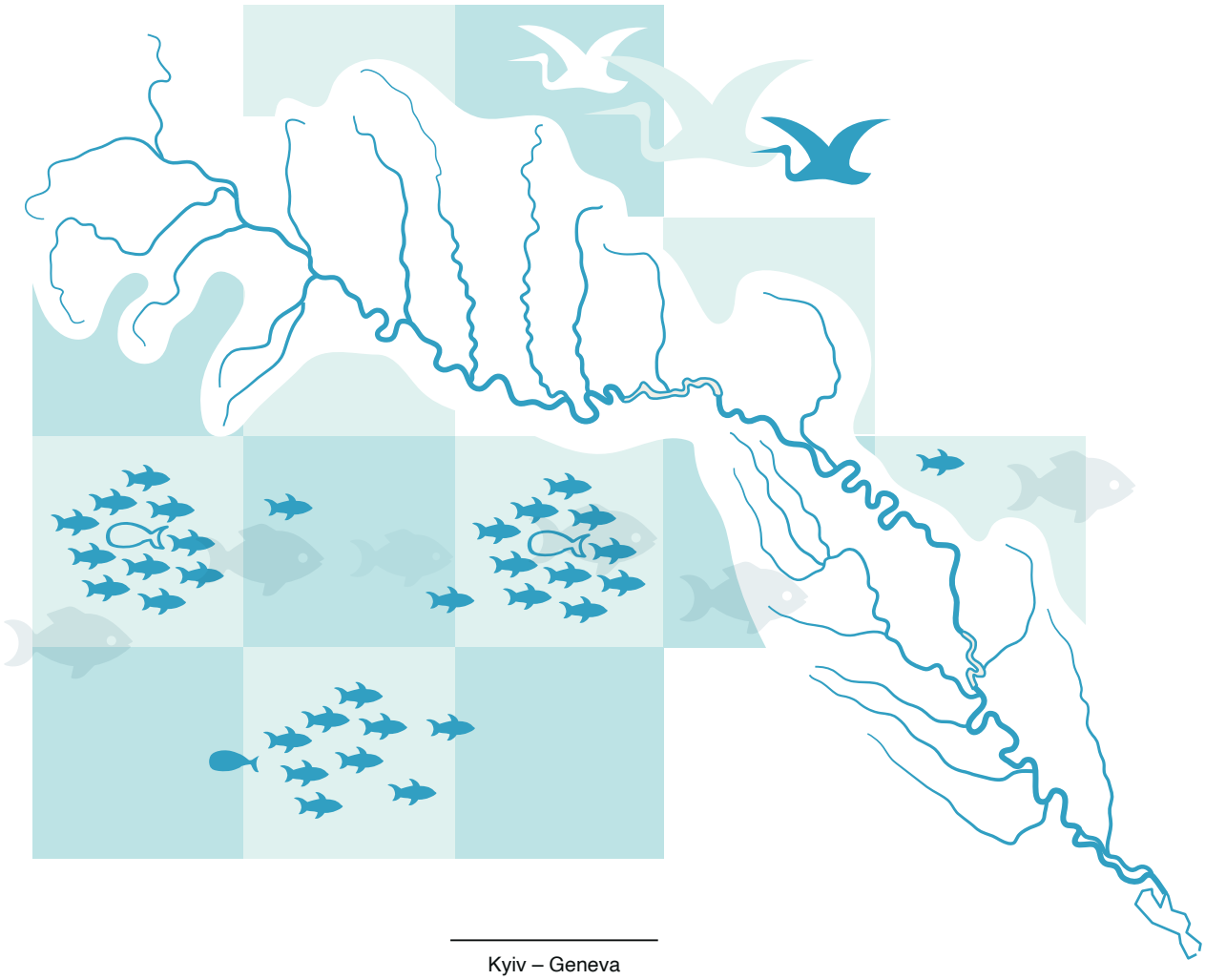
Global Environment Facility project

Enabling Transboundary Cooperation and Integrated Water Resources Management in the Dniester River Basin

Analysis of the goals, limitations and opportunities for optimizing the regime of spring ecological reproductive releases from the Dniester reservoir



Kyiv – Geneva
2020

This report has been prepared as part of the Global Environment Facility project “Enabling Transboundary Cooperation and Integrated Water Resources Management in the Dniester River Basin”. The project has been implemented by the UN Development Program and the Organization for Security and Cooperation in Europe in collaboration with the UN Economic Commission for Europe.

Text: Oksana Huliaieva (Ukrhydroenergo PJSC) and Nickolai Denisov (Zoï Environment Network).

Additional data, information, and valuable comments were provided by Agostino Avanzi (Idrostudi), Volodymyr Hubanov (Lower Dniester National Nature Park), Oleg Diakov (Center for Regional Studies), Vitalii Kolvenko (Tiraspol Hydrometeorological Center), Olga Lysiuk, Natalia Kharchenko, Mykhailo Khoriev (State Water Resources Agency of Ukraine), Oleksandr Usov (Institute of Hydrobiology of the National Academy of Sciences of Ukraine), Viktoriia Ustymenko (Chernivtsi Regional Department of the State Agency for Fisheries of Ukraine) as well as by members of the Working Group on River Basin Planning and Management under the Commission on Sustainable Use and Protection of the Dniester River Basin of the Republic of Moldova.

Cover design: Carolyn Daniel (Zoï Environment Network).

Overall coordination of the project: Tamara Kutonova (OSCE).

Publication is printed on FSC and PEFC certified paper.

1. Problem Definition

The present paper aims to explore and summarize potential scenarios of spring ecological reproductive release from the Dniester reservoir given their often conflicting and mutually exclusive objectives, requirements and limitations, and to demonstrate the impact of their formulation on the possibility of choosing one or another release scenario. As sources of information, the authors used current Operating Rules for Dniester Multi-Purpose Hydrosystem Reservoirs (Правила, 1987); draft new wording of the Operating Rules for Reservoirs of Dniester Cascade of HPPs and PSPPs (Проект, 2017) that have not been adopted yet; research results, and other publications related to the regime of spring release from the Dniester reservoir; additional data; opinions of experts and stakeholders presented inter alia during the meetings of the GEF project, the meetings of the Commission on Sustainable Use and Protection of the Dniester River[1], and the meetings of the Ukrainian Interdepartmental Commission on Coordination of the Modes of Operation of the Dnieper and Dniester Rivers[2] (hereinafter – the Interdepartmental Commission).

[1] The Dniester Commission was established under the Treaty on Cooperation in the Field of Protection and Sustainable Development of the Dniester River Basin between the Government of the Republic of Moldova and the Cabinet of Ministers of Ukraine (2012).

[2] The name is provided as of May 2020, while revision of the statutory documents and membership of the Commission is in progress.

2. Research Background and Mechanism of Spring Release Optimization

Spring ecological reproductive release from the Dniester basin has been carried out since 1988. After the first unsuccessful attempts, the State Agency of Water Resources of Ukraine (hereinafter – the State Water Resources Agency of Ukraine, and prior to that – the State Committee of the Ukrainian SSR for Water Management) invited specialists from the Institute of Hydrobiology of the Academy of Sciences of the UkrSSR for providing scientific rationale and improving the release regime.

The rationale of the release regime was provided based on the hydrological and hydrobiological data. In the first place, the correlation between the water level in the Dniester floodplains and discharge from the reservoir was established; also sensitivity of living environment and breeding of aquatic organisms and birds to these factors was identified (Шевцова и др., 1994). In the framework of the Interdepartmental Commission, the recommendations received were suggested for implementation and were partly used during the 1991 spring ecological release. During the same year, comprehensive hydroecological studies of the Dniester delta were organized, which demonstrated that the 1991 ecological release regime met the minimum necessary hydrobiological requirements (Шевцова и др., 1998)[3].

After 1991, the issues related to rationale and efficiency of the ecological reproductive release on the Dniester river were examined by many researchers, including V.N. Gontarenko (1993), I.T. Rusev (1997, 2013), V.I. Vishnevsky (2000), I.V. Shchegolev (2016) and others. Overall, the studies of the Institute of Hydrobiology of the National Academy of Sciences of Ukraine (Шевцова и др., 1994, 1997, 1998, 2003) and the research carried out in framework of the project “Climate Change and Security in Eastern Europe, Central Asia, and South Caucasus” (Губанов и др., 2016) can be considered the most comprehensive in terms of analyzing and justifying the release parameters and regime.

According to the established practice, before an annual meeting of the Interdepartmental Commission in the end of March (the current regulation envisages that the Commission should convene a meeting minimum once a month), the State Water Resources Agency of Ukraine collects written official proposals on the ecological reproductive release regime for the current year from stakeholders. Usually, such proposals contain a wide range of requirements concerning the peak flow, duration, flow curve shape, and timing of release. The meetings of the Interdepartmental Commission are open – the State Water Resources Agency announces them through official channels, and everyone willing to attend can take part in the discussion and present their reasoned point of view. In particular, such meetings are attended on a regular basis by participants from the Republic of Moldova as well as interested regions of Ukraine. The final decision based on the results of the discussion in the framework of the Interdepartmental Commission meeting is recorded in the meeting minutes and has to be approved by the Chair or the Deputy Chair of the State Water Resources Agency of Ukraine. Implementation of the adopted release regime is ensured by Ukrenergo NPC and Ukrhydroenergo PJSC.

[3] Base parameters of the 1991 spring release: beginning – April 15, duration – 21 days, release peak – 500-541 m^3/s for 5 days, average flow – 397 m^3/s.

The issue of spring release optimization remains complicated both in discussions and in practice, and the search for a balance between its different goals and limitations (see below) has caused repeated disagreements among the stakeholders in Ukraine and across the basin.

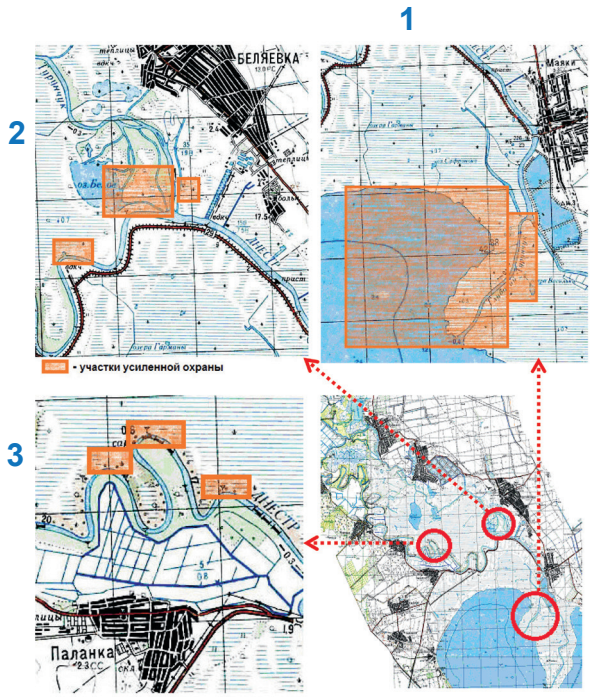
Whereas the State Water Resources Agency is officially responsible for overseeing implementation of the adopted release regime and analysis of the hydrological situation in the Dniester basin, it does not receive systematic information during the release about its efficiency and impact on the Lower Dniester ecosystems[4]. In general, today there is no system in place for assessing the ecological effectiveness of the release in progress, although the studies mentioned earlier suggest some notions in this regard[5].

[4] However, organizations from Odessa region and the Republic of Moldova occasionally provide such information on an irregular basis.

[5] Publications on restoration of water exchange in the lower reaches of the Dniester (Губанов и др., 2016) mention that flooding of floodplain meadows can be used as indicators for assessing efficiency of the release, which ensures spawning, as well as the number and species composition of birds on the waterlogged meadows. It is indicated that there is a direct correlation between flooding of the floodplain meadows during the release, and the species diversity, as well as the ichthyofauna and avifauna species numbers. However, the quantitative relationships between these indicators and the hydrological parameters of the release have not been studied yet, which hampers the use of this information for decision-making, especially in years when the spring flood is weak.

3. Overview and Analysis of Tasks, Requirements, and Limitations of the Spring Release

The principal tasks of the spring ecological reproductive release normally include flooding of the Dniester delta floodplain to create and maintain favorable environmental conditions there, as well as flooding of spawning grounds in the Dniester delta to create breeding conditions for fish of the phytophilous group (Fig. 1).



1 Upper reaches of the Dniester Liman, Glubokii Turunchuk river, Kilira erik

2 Beloye, Maloye Beloye, and Pogoreloye lakes

3 Stretch of the Dniester river in the area of Palanka village (Republic of Moldova)

Figure 1. Valuable spawning grounds in the Ukrainian part of the Lower Dniester

Source: Тромбицкий, Бушуев, 2012

These tasks determine a range of key parameters that were defined in various sources and summarized in Table 1. Table 2 summarizes the known release limitations related to characteristics, specific ecological features, and hydrological regime of the Dniester reservoir and the upper reaches of the Dniester.

Table 1. Requirements for the ecological release regime from the standpoint of the lower reaches of the Dniester[6]

	(a)	(b)	(c)	(d)
Release duration, full days	30	30	30	short
Minimum release volume, km^3	0.8	–	0.8	–
Peak release duration, full days	–	7	10	–
Minimum peak value, m^3/s	420–500	660	350–500	300–400
Optimum peak value, m^3/s	–	700–720	–	–
Period of time during which the delta floodplain is flooded[7], full days	20	20	–	–
Flow rate during 20 full days, m^3/s[8]	minimum 350	–	–	–
Daily change of water flow	smooth	smooth	50 m^3/s	–
Water temperature, °C:				
- at the start of the release (Mayaki)	–	10	8-10	April
- at the peak of the release (shallow waters)	12-13	–	–	–

Table 2. Release regime limitations from the standpoint of the upper reaches of the Dniester

	(a)	(c)	(d)
Admissible drawdown, m Baltic Height	slightly below 121[9]		
Daily drawdown, cm	maximum 10[10]		maximum 10
Maximum release volume, km^3		0.545	

Sources used for the tables:
(a) Institute of Hydrobiology of the National Academy of Sciences of Ukraine (Шевцова, 1998)
(b) Lower Dniester National Nature Park (Губанов и др., 2016)
(c) Interdepartmental Commission (meeting minutes for 1991–2020)
(d) Current Operating Rules (Правила, 1987)[11]

[6] The draft new wording of the Operating Rules (Проект, 2017) was not taken into consideration while compiling the table since it has not been finalized yet and contains some inaccuracies: there is no regulation for operating reservoirs in spring; limitations for water level fluctuations at 12 °C in the Dniester reservoir (20–25 cm) are indicated for the summer period; description of the ecological releases regime based on the research by the Institute of Hydrobiology of the National Academy of Sciences of Ukraine is included in the section on nature protection requirements.

[7] In practice it requires the flow from 350-400 m^3/s, see below.

[8] Materials of the project "Resilience Measures for Water-Related Ecosystems at Lower Dniester Ramsar Site" (Биотика, 2016) also quote the following information: "at 280–320 m^3/s releases from the reservoir, the water flows in the low-water channel. Water outflow into the river floodplain begins at the flow rate above 380–400 m^3/s". In terms of the floodplain flooding, this analysis assumes that water flows freely in the area where the M15 Odessa-Reni highway crosses the river floodplain, which does not always correspond to reality (Губанов и др., 2016).

[9] During the spawning period – after the reservoir water reaches the temperature of 12°C. However, according to ichthyologists from Chernivtsi region, the spawning grounds of the upper reaches of the Dniester reservoir are drained if the reservoir is drained below 119 m Baltic System. At the same time, many minutes of the Interdepartmental Commission meetings record the depth of the drawdown of the Dniester reservoir during the release up to 117 m Baltic System. During the summer period, in order to ensure successful reproduction of early spawning fish of the phytophilous group in the reservoir, it is also necessary to drain the level 2-3 m below the normal reservoir water surface to create conditions for slopes and islands to overgrow with meadow- and heath-grasses (Шевцова, 1998).

[10] According to ichthyologists from Chernivtsi region, this limitation is most relevant during the spawning period when the water level goes below the location of the spawning grounds (119 m Baltic System).

[11] Pursuant to Clause 4.4.1 "Regime during the spring period (March-May)" of the current Operating Rules (Правила, 1987), "the operating regime is set depending on the calculated maximum rate of the inflow into the reservoir. At the inflow rate up to 1000 m^3/s after the beginning of the spring flood, normal reservoir water surface is reached. At the rate above 1000 m^3/s the operating regime for the reservoir is set as envisaged by Section 5 (Procedure for flood passing through the Dniester hydrosystem). During floods with April flow rate recurrence of up to 75%, short-term ecological releases are carried out at the rate of 300-400 m^3/s".

Analysis of Table 1 demonstrates significant discrepancies in the number of base requirements from the standpoint of the lower reaches of the Dniester: overall release duration (from a short period to 30 days); duration of the maximum release flow (peak) period (7–10 days) and its rate (300—700 m^3/s); temperature conditions for the start of the release. Practically, this allows considering a wide range of release scenarios corresponding to certain values of the specified criteria.

However, the choice of scenarios (Table 2) is restricted by the characteristics of the Dniester reservoir, and the interests of fish stock breeding in the reservoir and in the upper reaches of the Dniester[12]. In the first place, there is limitation of depth (not lower 121 m) and the reservoir drawdown rate (maximum 10 cm per day) during the spawning period, with water temperature starting at 12 °C.

In real terms, fulfillment of the second requirement during the spawning period limits the maximum flow rate of the release without inflow[13] to 150 m^3/s (see below), which makes it possible to achieve the higher peak release flow expected by the lower reaches exclusively with additional inflow. At the same time, sufficient additional water inflow is most likely in the early spring period, during the natural flood peak when the water temperature in the lower reaches may not yet achieve 8-10 °C. Thus, simultaneous fulfillment of the requirements concerning a high peak flow and a sufficiently high water temperature in the lower reaches is extremely problematic, and their fulfillment will become increasingly difficult with a gradual decrease of the volume of snowmelt flood due to climate change (Стратегические направления, 2015).

It should be noted that before the Dniester reservoir was constructed, the floodplain system was flooded in high water season during different periods (Fig. 2a) and, respectively, at a vast range of water temperature values in Mayaki. With an average value of 9.5 °C, the mean ten-day water temperature during this period ranged from 2 °C to 16 °C while its distribution was quite even. After the HPP was built, the distribution curve has shifted noticeably towards higher temperatures – to 14–18 °C with the mean value of approximately 13 °C, whereas the share of low temperatures from 0 °C to 6 °C decreased significantly (Fig. 2b).

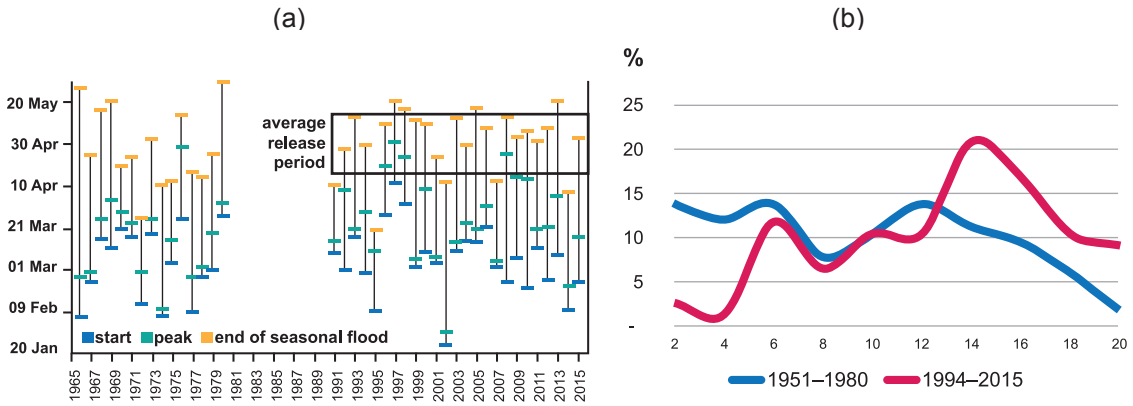


Figure 2. Correlation of the periods of seasonal flood and ecological reproductive release in the Dniester HPP site (a) and recurrence of average ten-day water temperature values (°C) in the area of Mayaki village during spring period with water flow rate in Bendery exceeding 400 m^3/s (b) before and after the Dniester HPP was built

Source: Hydrometeorological Center of Ukraine, Tiraspol Hydrometeorological Center

[12] Populated, among others, by rare and protected species, including sterlet (Кольман и др., 2016).

[13] I.e. release due to the reservoir drawdown per se, without including additional water inflow.

Finally, considerable limitations are also related to the total amount of water available for release from the Dniester reservoir without inflow. If the collected water reaches 121 m before the release began and the reservoir is drained to 117 m,[14] the volume of water available for release without inflow totals 0,545 km^3. With such volume, rather high water flow rate can be maintained for a significant period of time (see below).

However, if the collected water does not reach 121 m because of insufficient inflow in winter and (or) insufficient volume of the spring flood, the volume of water actually available for release without inflow is lower. Similarly, the volume of water available for release decreases if the year is expected to be dry, and the drawdown up to 117 m conflicts with the necessity to accumulate a sufficient amount of water in the reservoir to provide Moldova and Odessa region of Ukraine with water in summer.[15] Therefore, we can see an objective contradiction, especially in dry years, between a potential amount of water available for release without inflow, and the desired volume and duration of the release to ensure the flooding of the delta floodplains and lower reaches of the Dniester.

[14] Strictly speaking, this is possible only outside the spawning period in the Dniester reservoir, which, in its turn, contradicts the requirements of the lower reaches of the Dniester concerning water temperature during the release period.

[15] It can be reasonably assumed (Стратегические направления, 2015) that with the climate change such situations will occur more and more often.

4. Calculation and Discussion of Possible Spring Release Scenarios

For a more detailed study of specific possibilities for meeting the requirements and limitations in real conditions, the correlation between key parameters of the release conditions and the flow curve was examined, including:

- the volume of water available for release without inflow (determined by the level at the start of the release and the acceptable depth of the reservoir drawdown);
- expected mean water inflow during the release period;
- the peak release flow value and its duration;
- the rate of flow change on the rise and fall of release flow curve (for the sake of simplicity, scenarios were examined with smooth increase and decrease of the flow rate of release without inflow);
- the maximum acceptable rate of the water level decrease in the reservoir.

Quite simple calculations using the volume curve[16] for the Dniester reservoir demonstrate that there is a simple unambiguous correlation between the value of release without inflow and the reservoir drawdown intensity (Fig. 3).

With its help, it is easy to construct a nomogram (Fig. 4) for the achievable maximum (peak) release taking into account the natural inflow at the selected range of water level fluctuations in the reservoir.

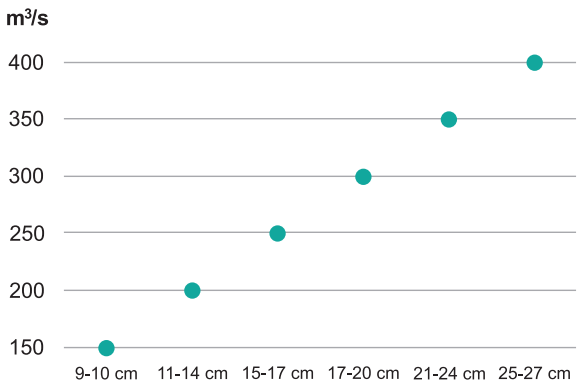


Figure 3. Correlation between the maximum flow rate of release without inflow and daily decrease of the water level in the reservoir

[16] For calculations, the volume curve from the current Operating Rules was used (Правила, 1987). It is different from the volume curve included in the draft new wording of the Rules (Проект, 2017).

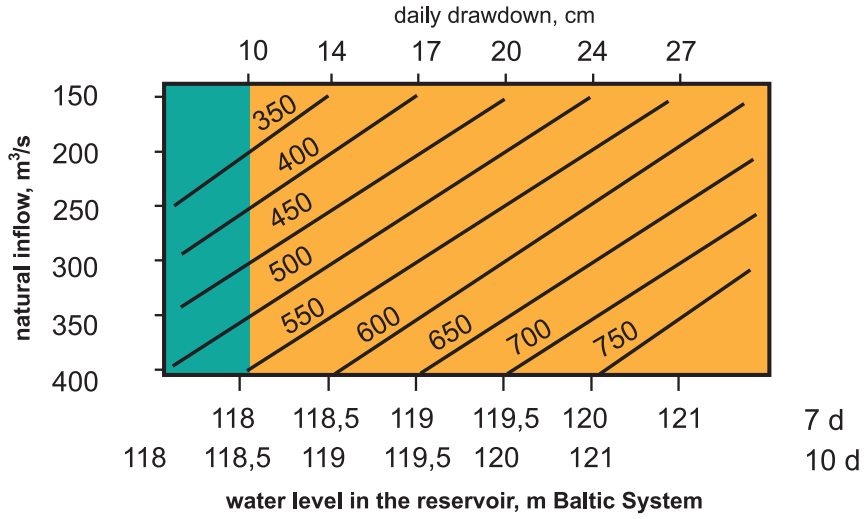


Figure 4. Nomogram of the maximum achievable water flow (values on the nomogram lines in m³/s) for releases with the peak duration of *7* and *10 days* depending on natural water inflow and admissible daily drawdown of water in the reservoir

Note: the lower horizontal scale indicates the minimum initial level mark, at which a release with such parameters is possible depending on the peak duration

Practical feasibility of the release with such characteristics depends on the ratio between the volume of water available in the reservoir for release without inflow (see above) and the selected release flow curve, which determines the required volume of water. The lower scale on Figure 4 shows this dependence for two families of idealised flow curves – with a peak flow maintained for 7 and 10 days. Respective flow curve families are shown on Figure 5[17].

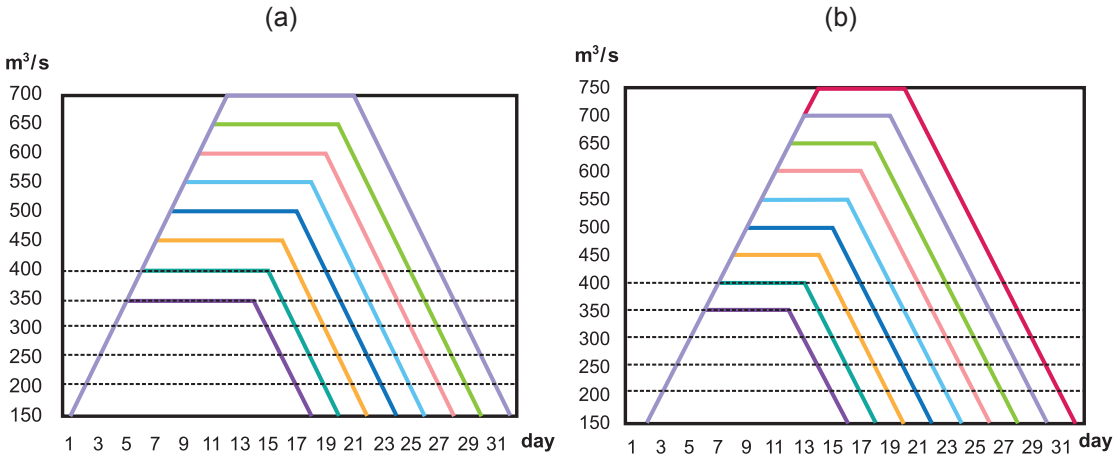


Figure 5. Flow curves for releases of various volumes with ten-day (a) and seven-day (b) peak durations and daily flow rate variation during the rise and fall of 50 m3/s

Note: flow rates for the natural inflow at the base of flow curves are shown in a dotted line

In both cases (a) and (b), it is assumed that the reservoir is drained to the level of 117 m, and that the flow rate of release without inflow increases evenly from the level of natural inflow to the peak and decreases after that at the rate of 50 m³ per day (and is constant during the full day). Similarly to Figure 4, the natural inflow values from 150 to 400 m³/s are used for the calculation.

[17] It should be noted that the drawdown of the reservoir volume at above 150 m³/s automatically violates the requirement to limit daily fluctuations in the water level in the reservoir to 9-10 cm.

Shorter flow peak makes it possible to save water and, providing sufficiently large fluctuations of the water level in the reservoir exceeding the current limits are allowed, to reach higher maximum values. The need for water also decreases when a higher than accepted in practice daily rate of change in the flow rate is allowed, resulting from a faster approach to the peak flow[18]. Therefore, flow curves in Figure 6 allow a higher peak within the same peak periods of 7 and 10 days.

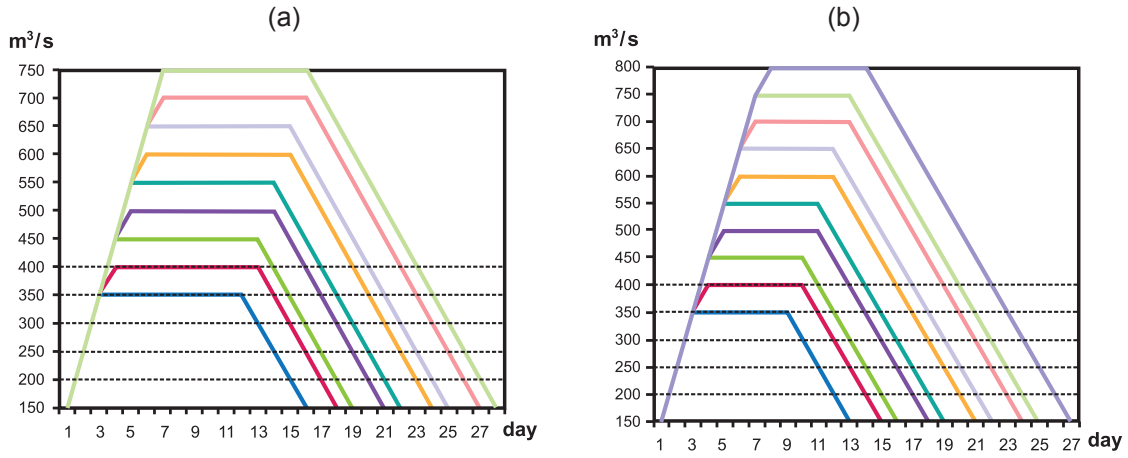


Figure 6. Flow curves for releases of various volumes with ten-day (a) and seven-day (b) peak duration and daily flow change of 100 m^3/s on the rise and 50 m^3/s on the fall

Note: flow rates for the natural inflow at the base of flow curves are shown in a dotted line

Under specific conditions, the choice of regime normally starts from the idea that a higher and longer peak flow will provide more intensive washing of the Dniester delta as well as longer and more stable flooding of the floodplain ecosystems of the lower reaches of the Dniester. In this way, the best conditions will be created for existence and reproduction of water and near-water ecosystems and species of the lower reaches of the river. In the absence of sufficient understanding of quantitative correlations between the release characteristics and indicators of the state of ecosystems, one uses the ideas about

- the desired height of the release peak (first of all, from the point of view of washing of the floodplains and erik channels);
- the minimum release flow ensuring water outflow to the floodplain and hence flooding of the delta and spawning grounds; and
- the desired period of time, during which such flow is maintained, also for ensuring the minimum duration of spawning conditions for various fish species.

Due to the structure of the Dniester river bed, there is no noticeable “spreading” of the waves of floods and releases in the stretch from the Dniester reservoir dam to Dubossary-Bendery. The flow curve shape in the area remains practically unchanged except for the decrease of sharp peaks within a few percent range. When the release is carried out at the end of the flood, the flow in the Dniester HPP – Bendery stretch in most cases even increases slightly due to lateral inflow. A significant transformation of the flow curve can be seen after the riverbed separation, where the maximum flow is decreased by 40–50 %.

[18] Analysis of the natural hydrological regime of the Dniester gives grounds to assert that the change in the water flow during the spring flood at the rise of the flow curve (on average 90 m^3/s per day) occurs more intensively than at its decline (45 m^3/s per day). Accordingly, the time for reaching the peak of the natural flood flow is two times less than its decline duration. A similar correlation, with the rise of the flow curve by 100 m^3/s per day, for the purposes of water saving can be recommended for the ecological reproductive release as well.

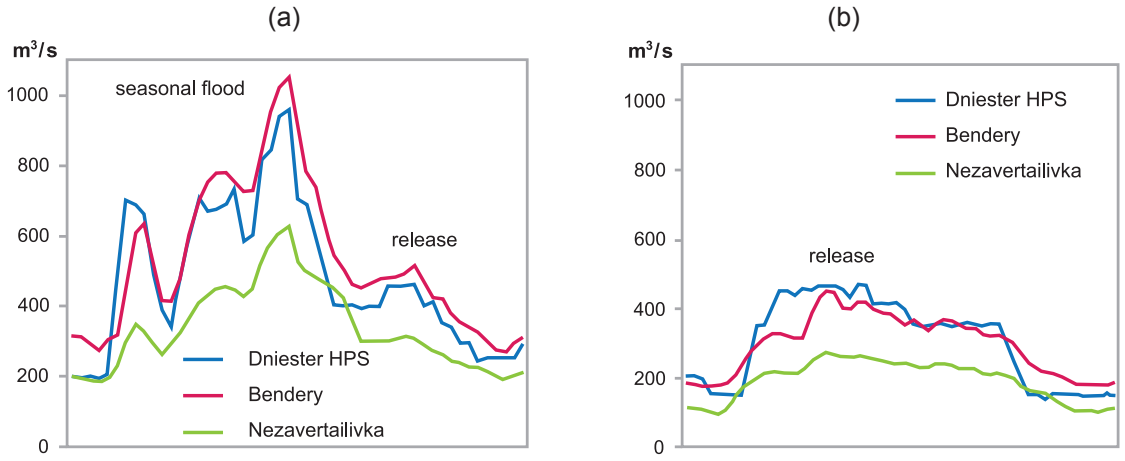


Figure 7. Springtime flood runoff flow curves combined with ecological reproductive release taking into consideration the flow time in 2003 (a) and 2008 (b)

Source: Hydrometeorological Center of Ukraine, Tiraspol Hydrometeorological Center

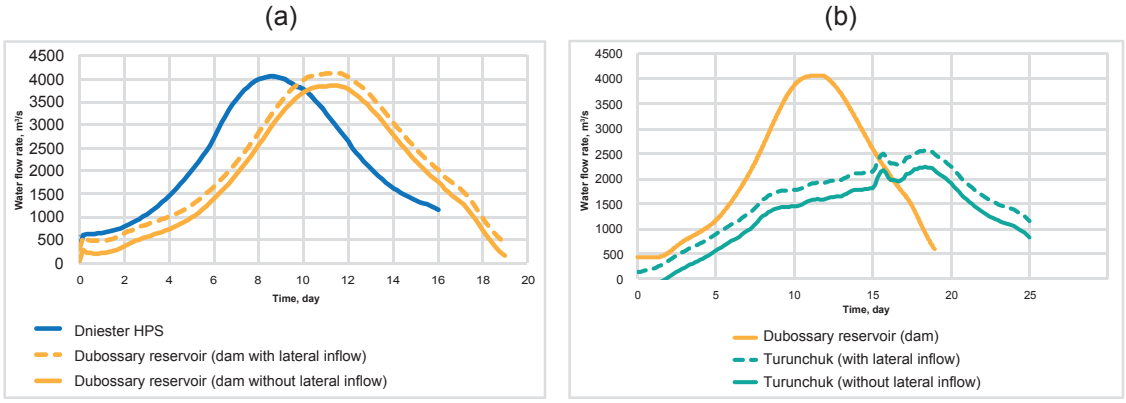


Figure 8. Results of modeling the transformation of the river flood flow curve with 1% coverage at different areas of the Dniester

Source: Idrostudi, methodological questions in (BETA Studio, HR Wallingford, 2016)

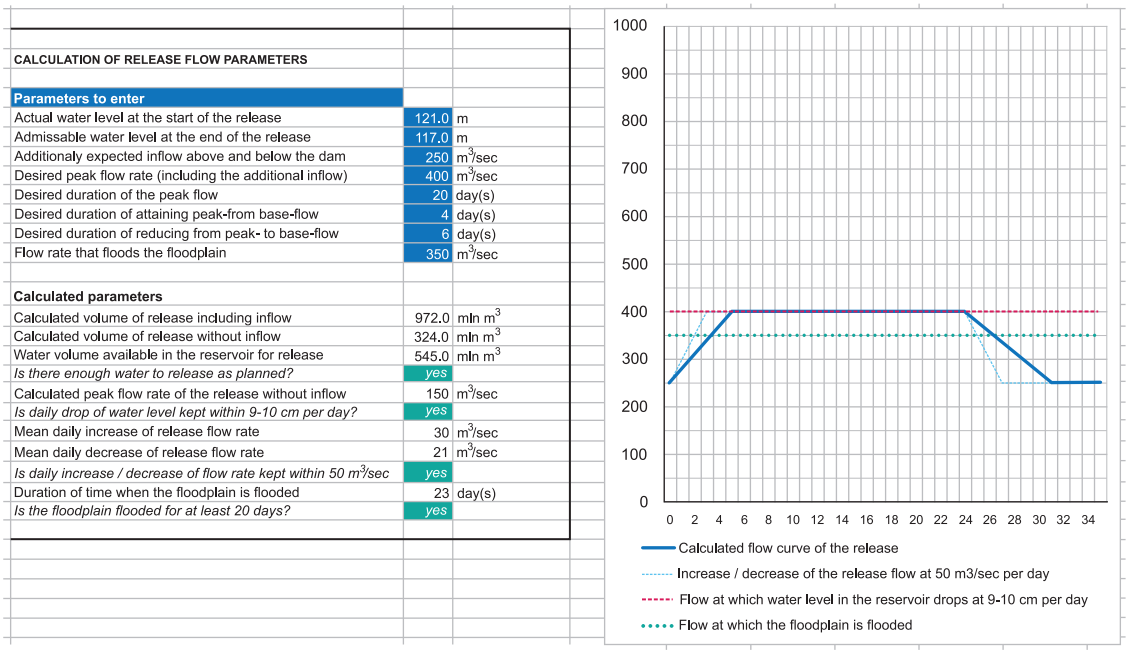
These patterns are confirmed both by comparison of the water flow data at the Dniester HPP, Bendery and Nezavertaylovka (Fig. 7), and by the results of mathematical modelling of the flood wave movement (Fig. 8). In the estuary area, the hydrological regime typical of the river gradually turns into that of the liman[19].

Therefore, for the purposes of tentative assessment of the release efficiency from the point of view of flooding the delta, it is quite possible to use the water flow rate characteristics near the Dniester reservoir dam and the range of 350–400 m^3/s as a criterion for water flowing out to the floodplain

[19] On average, the time of flood or release movement from the cascade of the Dniester HPPs to Nezavertaylovka village totals 4-5 days depending on the flow rate. The wave crest moves with the speed of 1.4-1.9 m/s, which corresponds to the movement wave. The water reaching the upper section of the estuarial area (Gradenitsy-Nezavertaylovka and Troitskoye-Olanesht), flows out to the floodplain, where fluctuations in the water level are approximately two times lower than in the river. During big floods and high-water seasons, the amplitude of water level fluctuations can reach 3-4 m. Near the Dniester Liman, the magnitude of water level fluctuations caused by river runoff decreases significantly. For instance, the area located between the Mayaki-Palanka and Krasnaya Kosa-Nadlimanskoye sites has the same low-water level marks as the Dniester Liman. Annual fluctuations of the level here average 0.5–0.6 m, and during high floods – up to about 1 m. Specific features of the liman regime at the river estuary include amplification of up and down surges, which can lead to fluctuations in water level up to 0.5-0.7 m (Гидробиологический, 1992). It should also be noted that the statement about virtual absence of "spreading" of the flood and release waves on the stretch from the Dniester HPP to the upper section of the river estuary is valid only when the Dubossary reservoir operates in the transit mode. If the reservoir is being filled at this time, the peak of the flood or release wave may be reduced significantly (e.g., by almost 30% in May 2020 – from 700 to 500 m^3/s).

and flooding it. A more accurate analysis, including that of the water depth on the floodplain at different flow rates, requires hydraulic modelling and a digital terrain model of the lower reaches of the Dniester. Additional studies are also necessary of the conditions of water passage near the bridge on the Mayaki-Palanka stretch of M15 motorway, and of the impact of up and down surges in the Dniester delta on the release wave transformation.

In addition to the graphs and nomograms presented above, an interactive 'calculator' was developed for a simplified approximate calculation of certain release parameters under different conditions (Fig. 9).



CALCULATION OF RELEASE FLOW PARAMETERS		
Parameters to enter		
Actual water level at the start of the release	121.0	m
Admissable water level at the end of the release	117.0	m
Additionaly expected inflow above and below the dam	250	m^3/sec
Desired peak flow rate (including the additional inflow)	400	m^3/sec
Desired duration of the peak flow	20	day(s)
Desired duration of attaining peak-from base-flow	4	day(s)
Desired duration of reducing from peak- to base-flow	6	day(s)
Flow rate that floods the floodplain	350	m^3/sec
Calculated parameters		
Calculated volume of release including inflow	972.0	mln m^3
Calculated volume of release without inflow	324.0	mln m^3
Water volume available in the reservoir for release	545.0	mln m^3
Is there enough water to release as planned?	yes	
Calculated peak flow rate of the release without inflow	150	m^3/sec
Is daily drop of water level kept within 9-10 cm per day?	yes	
Mean daily increase of release flow rate	30	m^3/sec
Mean daily decrease of release flow rate	21	m^3/sec
Is daily increase / decrease of flow rate kept within 50 m^3/sec	yes	
Duration of time when the floodplain is flooded	23	day(s)
Is the floodplain flooded for at least 20 days?	yes	

Figure 9. Interactive 'calculator' for calculation and assessment of spring release parameters

The 'calculator' uses MS Excel to enable assessment of a possibility to achieve certain target values and comply with limitations set forth in Table 1 and 2 using the minimum set of input parameters defining the desired release mode. As such, the tool can be used to support operational decision-making when comparing and selecting specific release scenarios depending on the hydrological situation, requirements, limitations and expectations of the process participants.

5. Conclusions and Recommendations

(1) A number of formal and informal requirements and restrictions, often contradictory in nature, are put forward for the regime of spring environmental reproductive release from the Dniester reservoir. Typical flow curves, nomograms and a scheme for automated analysis and calculation of a release flow curve, calculated within the framework of this activity taking into consideration the basic requirements and limitations, can be used as working tools for preparing and conducting an annual discussion of the release regime within the framework of the Interdepartmental Commission and interstate dialogue. There is a need for further development of tools for such analysis.

(2) For further improving understanding of the goals, limitations, and effectiveness of ecological reproductive release, it is necessary to continue to study a number of issues, including:

- assessment of quantitative correlations between ecological indicators characterizing the Lower Dniester spawning grounds and ecosystems, and hydrological parameters of the release, with the following substantiation of clear and understandable requirements concerning the conditions for flooding of the delta floodplains (volume, peak, duration, flow curve shape, temperature) and spawning grounds;

- analysis of the correlation between the release flow curve and the water level in the Dniester delta and floodplain (a more detailed analysis of the nature and reasons of the release wave transformation during its movement along the river, the flow rate ensuring the flooding of the floodplain, the area and proportion of flooding of meadows and spawning grounds depending on the water flow);

- research and substantiation of clear and understandable limitations of daily fluctuations, overall change of the water level and temperature in the Dniester reservoir during the release period (including those related to creating spawning conditions for valuable fish species and the operation of water intake facilities);

- analysis and substantiation of the total allowable drawdown of the Dniester reservoir during the release period depending on the expected hydrological conditions during the year, including analysis of the fundamental possibility of filling the reservoir to a forced mark if necessary, and clarification of the volume curve (dependence of the reservoir volume on the level of water in it).

In order to ensure monitoring of the release efficiency every year during the spring period it is necessary to organize collection of information about the situation with floodplain meadows, spawning grounds, species diversity, ichthyofauna and avifauna numbers in the lower reaches of the Dniester as well as regular exchange of such information among stakeholders in Ukraine and the Republic of Moldova, for instance, within the framework of the Dniester Commission working groups.

(3) In order to ensure further optimization of the release regime and examination of its attainable scenarios by the Interdepartmental Commission within the framework of reasonable requirements and limitations, it would be expedient to hold an open discussion involving all the stakeholders and, if possible, change some of the applicable requirements and limitation of the release regime, including:

- water temperature determining the starting time of the release;
- limitation of daily drawdown of the reservoir during the release period;
- admissible daily increase of the water flow at the rise of the release flow curve;
- fundamental need for annual release that meets the specified requirements as opposed to periodic imitation of hydrological and temporal parameters of the natural spring flood.

In the future, it looks expedient to change the procedure for annual submission of proposals to the Interdepartmental Commission proceeding exclusively from achievable scenarios within the requirements and limitations agreed on a long-term basis. After an agreement about the latter requirements and limitations is reached, it can be formalized, for instance, in the new wording of the Operating Rules for the Dniester Reservoirs. It also seems timely to consider the necessity and possibilities of strengthening the mechanism for transboundary harmonization of release parameters within the framework of the Commission on Sustainable Use and Protection of the Dniester River Basin.

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