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ORIGINAL ARTICLE

Ecological risks in river basins: a comparative analysis of steppe and forest Ukrainian areas

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One of the most important goals of the state environmental policy of Ukraine for the period up to 2030 is to reduce the environmental risks in order to minimize their impact on ecosystems, socio-economic development, and public health. This, in turn, is possible after reducing anthropogenic load and introducing environmental risk management. The purpose of the research was to establish the peculiarities of the ecological risk formation in deteriorating river basins for different natural and climatic zones of Ukraine on the example of the rivers Styr (Western Polissya) and Molochna (Steppe zone). The river basins within different natural and climatic zones of Ukraine differ in surface runoff formation, hydrological, hydrochemical regimes, and the features of aquatic ecosystems. However, these are affected by similar anthropogenic factors, resulting in conditions for emerging risks of the river basins' ecological status deterioration.
Establishing the anthropogenic load level and evaluating the ecological status of Styr and Molochna River basins that were made using the induction coefficient of the anthropogenic load (ICAN): this showed that in the basins of these rivers, there is excessive usage of the land and water resources. Moreover, there is also a probability of environmental risks emerging in these rivers' deteriorating basins related to the degradation processes development. Because of the water quality evaluation in the rivers Styr and Molochna, it was established that primarily the pollutants belonging to the trophy-saprobiological block determined the water quality in the rivers. For the Styr River, heavy metal pollution (block of toxic and radiation substances) is also inherent, but their high content is also natural. The interactive development of the World Resources Institute (WRI), using the Aqueduct geospatial database, allowed us to establish the probability of water risk in the Styr and Molochna River basins and predict the development of environmental risks and water stress. It has been established that the Molochna River basin, which is located in the Steppe zone of Ukraine, is more vulnerable to the development of environmental risks. Thus, the anthropogenic factors, under the influence of which the ecological state of river basins in the zone of Western Polissya and Steppe zones of Ukraine are formed, significantly level the natural features of these basins' processes create the conditions for ecological risks with similar consequences.
Keywords: river basin, ecological risks, anthropogenic load, ecological condition, water quality, degradation processes, water risk, water stress.

Introduction

At the present stage, the concept of risk assessment in almost all countries is considered the primary mechanism to develop and make management decisions at the international, national, regional levels, and individual production level or the other potential source of pollution (Adamenko, 2011). For the most part, the concept of environmental risk is identified with the specific threats of technogenic and anthropogenic nature, which cause the changes in natural objects and factors with likely negative consequences for the society, including human health (Illiashenko and Bozhkova, 2005). Today, the risk assessment is an essential analytical tool that allows identifying factors that can be a threat to human health, to establish their relationship, and on this basis to outline the priorities for risk minimization (Serdiuk and Buravlov, 2002).
Environmental risks are directly associated with environmental pollution (Kniazevskaia and Kniazevskyi, 1998), with the probability of degradation or destruction of the ecological object due to the environment's changes (Oleinyk, 2000). The

environmental risk for water objects is based on an integrated evaluation considering the volume of water consumption, discharges of untreated wastewater, drinking water supply needs, and surface water quality analysis compared to the TLV (Adamenko, 2011). Determining the environmental risk of water objects deterioration (Demianova and Rybalova, 2013) involves considering hydrochemical, hydrobiological, and sanitary-toxicological indicators. The approaches to assessing the risks arising from the water supply to the population from the sources of centralized and decentralized water supply allow taking into account the natural conditions of groundwater formation, the technical condition of water supply systems, and water quality (Likho and Hakalo, 2013).

In foreign publications, the issue of environmental water risk (stress) is based on various approaches. Including: based on estimates of water needs in households, agricultural production, industry, energy and environmental needs for conservation of aquatic ecosystems is based on Water Stress Index, Falkenmark Index (Falkenmark 1989), defining the threshold between "general water management problems" and "water stress" (Engelman & LeRoy, 1993), or a hydrological model based on the analysis of the effects of climate change and socio-economic progress (Alcamo et al ., 2007).

The Law of Ukraine "On Basic Principles (Strategy) of the State Environmental Policy of Ukraine until 2030" states that one of the most important goals is to reduce the environmental risks to minimize their impact on ecosystems and socio-economic development, and public health. This, in turn, is possible if the level of surface and groundwater pollution is reduced and the introduction of environmental risk management based on its modelling in real time with the use of the latest information technologies to protect natural ecosystems, health, and welfare of the population. (Law of Ukraine, 2019). Therefore, the issue of environmental risks for deteriorating river basins in Ukraine is extremely relevant.

The latest approaches to determine the environmental risk include the use of GIS technology in researches. The use of geoinformation approaches to determine the total transformation of the state and river systems functioning allows obtaining a geoinformation model of changes in the river basin's process-forming factors. The analysis and modeling algorithm is based primarily on the hydrographic characteristics dynamics, morphometric parameters analysis of the riverbed with a subsequent trajectory of adverse exogenous geological processes (Trofymchuk and Trysniuk, 2012). According to the developed concept (Brauman et al., 2016), the Steppe zone of Ukraine's watersheds was determined, which are subject to depletion. The main factors determining the formation of this situation are the region's arid climate with a lack of precipitation and the long periods of drought, active agricultural activities, including the use of water melioration.

The river basins within different natural and climatic zones of Ukraine differ in surface runoff formation, hydrological, hydrochemical regimes, and the features of aquatic ecosystems. The deterioration of river basins' ecological condition in Ukraine due to toxic, microbiological, and biogenic pollution is observed. The Black Sea estuaries' unsatisfactory condition should be noted particularly, most of which belong to the nature reserve fund and are unique recreational resources. The discharges from industrial facilities, improper condition of drainage infrastructure and treatment facilities, non-compliance with water protection zones, flushing, and drainage of toxic substances from agricultural lands are the primary sources of water pollution. The main substances that cause pollution are heavy metal compounds, nitrogen and phosphorus compounds, petroleum products, phenols, sulfates, and surface-activated substances. The contamination with medical waste and microplastics, which is currently uncontrolled, has been growing recently. Water pollution results in various population diseases, reducing organism resistance and increasing the overall incidence, particularly of infectious and oncological diseases (Law of Ukraine, 2019). Thus, the river basins in different natural and climatic zones of Ukraine are affected by anthropogenic factors, created the risks of their ecological status deterioration.

The concept of water scarcity is analyzed using a water voltage indicator, which shows what proportion of water in the world's river basins is removed for human needs and where this usage level is contrary to the Environmental Water Requirements (Revenga et al., 2004).

The purpose of the work is to establish the peculiarities of the ecological risk formation in deteriorating river basins for different natural and climatic zones of Ukraine on the example of the rivers Styr (Western Polissya) and Molochna (Steppe zone). The research object is the processes of forming the ecological state of Styr and Molochna River basins under the influence of natural and anthropogenic factors that determine the possibility of environmental risks.

Materials and methods

The Styr River flows through Western Polissya; it is a right tributary of the Prypiat (Dnipro basin). The river originates in the Lviv region, flows through the Volyn and Rivne regions. The length on the left arm is 437 km, on the right - 494 km, the catchment area before branching is 11700 km^2, total - 13000 km^2. The Styr River basin is located in two geomorphological regions: its upper and middle parts are located on the Volyn-Podolian upland and spurs; the lower part is situated in the Great Polissya plain.

The Molochna River is located in the Steppe Zone in the Zaporizhzhia region; it flows into the Molochnyi estuary of the Azov Sea basin. The length is 197 km; the catchment area of the river is 3450 km^2. Its upper reaches are located within the Azov Sea upland. The middle part is on the Azov Sea upland's western slope, and then the Molochna River flows along the Black Sea lowlands.

Results and discussion

According to the concept provisions (Davison et al., 2005), risk management consists of several interrelated stages: risk identification, i.e., identification of the primary sources of wastewater to the river, the nature of its catchment area and water quality; the analysis, characteristics, and assessment of the identified risks; the development of the measures to eliminate or minimize risks.

Identification of the anthropogenic load and evaluation of the basins of the Styr and Molochna Rivers' ecological condition was carried out using the induction coefficient of the anthropogenic load (ICAN), determined by the hierarchical logicalmathematical principle. There are four main subsystems for analysis: radioactive contamination of the territory, land use, river draining usage, and water quality. Each subsystem is characterized by a set of criteria and indicators that classify the river basin's state. Moreover, according to their estimates, it classifies the entire subsystem. In general, the ecological state of the river basin is described by a vector of classes alternatives $K = (K_1 = 3, K_2 = 1, K_3 = 0, K_4 = -1, K_5 = -3, K_6 = -4)$, the state of the system, respectively can be "good", "insignificant change", "satisfactory", "poor", "very poor", "catastrophic" (Yatsyk et al., 2007). The results of the ecological status evaluation for Styr and Molochna River basins are shown in Table 1.

Table 1. Ecological Status Evaluation for Styr and Molochna River Basins

No	Indicator	Basin of Styr River			Basin of Molochna River		
		Meaning	Measure	Qualitative Evaluation	Meaning	Measure	Qualitative Evaluation
	"Radiation Pollution"						
1.	Caesium, K_i/km^2	3.04	0	Satisfactory	0.1	0	Satisfactory
2.	Strontium, K_i/km^2	0.09	0	Satisfactory	0,05...0,1	0	Satisfactory
3.	Plutonium, K_i/km^2	-	0	Satisfactory	-	0	Satisfactory
	Subsystem status		0	Satisfactory		0	Satisfactory
	"Land Use"						
1.	Forest cover, %	20.23	-4	Unsatisfactory	4.0	-1	Above normal
2.	Natural state, %	21.07	-4	Unsatisfactory	18.5	-4	Considerable
3.	Agricultural development, %	12.97	4	Good	79.0	-1	Above normal
4.	Plowing, %	9.83	4	Good	76.0	-4	Considerable
5.	Urbanization, %	10.73	-4	Unsatisfactory	6.4	1	Low
6.	Erosional feature, t/ha per year	<2.0	4	Good	0,5...1,5	4	Very low
	Subsystem status L_n		-3	Unsatisfactory		-3	Unsatisfactory
	"River Draining Usage"						
1.	Actual river draining usage, %	27.84	-5	Catastrophic	138	-5	Very high
2.	Irreversible water consumption, %	22.48	-3	Very poor	153	-5	Very high
3.	Water discharge into the river network, %	7.42	1	Satisfactory	39.7	-5	Very high
4.	Contaminated wastewater discharge, %	1.49	1	Satisfactory	0.5	3	Low
	Subsystem status W_n		-4	Very poor		-4	Catastrophic
	"Water Quality"						
1.	Pollution index with salt components	1.7	1	Pure	5.3	-1	Moderately polluted
2.	Trophic-saprobiological index	4.4	0	Slightly polluted	4.2	0	Slightly polluted
3.	Specific substances of toxic action index	3.2	0	Slightly polluted	3.8	0	Slightly polluted
4.	Integrated ecological index	3.1	0	Slightly polluted	4.4	0	Slightly polluted
	Subsystem status Q_n		1	Pure		-1	Moderately polluted
		Class of water quality - II Water quality category - 3			Class of water quality - III Water quality category - 5		
	"Induction Coefficient of Anthropogenic "Load" (ICAL)						
Basin state	K_n		-1	Poor		-2.2	Very poor

According to the set of all criteria, the basin of Styr River's ecological condition is evaluated as "poor". The "Land Use" and River Draining Usage" subsystem became decisive. It is established that the generalized state of the "Land Use" subsystem (indicators: forest cover, urbanization, natural state of the system) within the Volyn upland is defined as "extremely unsatisfactory", and for Volyn Polissya as "unsatisfactory". The condition of "River Draining Usage" subsystem (indicators: actual river draining usage, irreversible water consumption) within the Volyn upland is defined as "good", and for Volyn Polissya as "very poor".

The general state of the Molochna River ecosystem according to the ICAN index can be described as close to the "very poor" state. The most important factors that cause this state of the river basin are the indicators of the same subsystems: "Land Use" (indicators: plowing, erosional feature, and actual natural state of the catchment system) and "River Draining Usage" (indicators: actual river draining usage, irreversible water consumption, water discharge into the river network). Thus, in the basins of Styr and Molochna Rivers, there is an excessive use of land ("Land Use" subsystem) and water resources ("River Draining Usage" subsystem), which causes the probability of environmental risks.

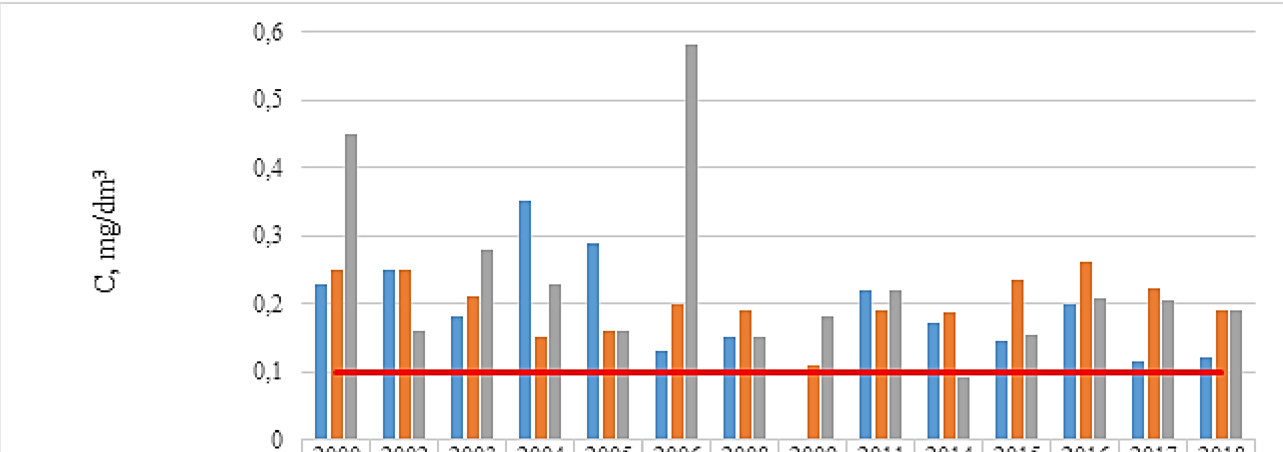
The "Comprehensive Assessment of the Water Objects Ecological Status" (Vasenko et al., 2012) determined the intensity of degradation processes within the studied river basins. The study is based on the "negative" factors analysis that causes or may accelerate the process of ecosystem destruction and "positive" factors, which can stabilize the ecological state of the aquatic ecosystem. Some unfavorable natural factors (gully development, waterlogging, the erosional feature of lands, siltation) and destructive anthropogenic factors (plowing (43.8% - Styr River basin; 72.8% - Molochna River)), urbanization (10.6% - Styr River basin; 6.4% - Molochna River), water intake, wastewater inflow to the river). The "positive" factors of river basins ecosystems stabilization and improvement include forest cover (29.3% - Styr River basin; 4.0% - Molochna River), salinity (11.3% - Styr River basin; 13, 0% - Molochna River), lake percentage, river drainage change indicator. The list of "positive" indicators should also include the nature reserves, which are characterized by the ecosystems' primary balance and resilience. In the Styr River basin, the area of nature reserves is 2.8%; in the basin of the Molochna River, it is 0.93%.

When applying this technique, it is also advisable to consider the impact of water melioration (area of drained or irrigated lands, the volume of irrigation water) and the amount of fertilizer per unit area of the agricultural land.

The coefficient of the development direction of degradation processes in the river basins (K_H) is determined by the magnitude ratio of the negative impact of anthropogenic factors (S_a^-) to the positive impact magnitude of natural factors (S_{es}^+). If $S_a^- > S_{ec}^+$, $K_H > 1$ - anthropogenic factors significantly affect the development of degradation processes in river basins, there is a possibility of environmental risks, gradual destruction of the ecosystem. The value of $K_H>1$ indicates the urgent need to develop a set of compensatory environmental measures based on the analysis of the importance of the factors that minimize the adverse effects of constant anthropogenic load and slow down the formation of environmental risks and their possible consequences. For the basin of Styr River K_H=1,9, Molochna River K_H=1,7. Thus, there is a probability of environmental risks in deteriorating the basins of these rivers.

River water quality is one of the leading indicators that reflects the ecological condition of the basin. As mentioned above, the studied watercourses belong to the hydrological zones with natural hydrochemical features. An increased total iron concentration is observed in the Styr River (Fig. 1). Usually, the iron enters the reservoirs with the industrial effluents, but it is also necessary to consider the background concentrations and natural features of their formation. It should be noted that the part of the heavy metals enters the water due to their leaching from the crystalline rocks of the Ukrainian Shield, the northern part of which is located in Polissya (Mitskevych, 1971).

The basins of the Pryazovia rivers are characterized by an increased content of chlorides, sulfates, and a high total mineralization level (Fig. 2), due to the catchment area's edaphic conditions and increased content of relevant substances in the underground aquifers. The average mineralization level for the last 27 years was 3522 mg/dm^3, sulfates - 1301.8 mg/dm^3, chlorides - 635 mg/dm^3. The high content of salt block substances limits the use of river water for economic, technical needs and the irrigation of agricultural lands. The highest content of chlorides and sulfates is observed in the wellhead section of the river. It is established that the principal amount of chlorides enters the river because of the interaction of precipitation with soils, especially with the saline one. The primary source of chlorides and sulfates is igneous rocks, which include chlorine-containing minerals and saline deposits, as well as highly mineralized aquifers (Datsenko et al., 2014).



	2000	2002	2003	2004	2005	2006	2008	2009	2011	2014	2015	2016	2017	2018
423 km from estuary	0,23	0,25	0,18	0,35	0,29	0,13	0,15	0	0,22	0,171	0,144	0,199	0,116	0,122
150,5 km from est.	0,25	0,25	0,21	0,15	0,16	0,2	0,19	0,11	0,19	0,187	0,234	0,263	0,222	0,189
74 km from estuary	0,45	0,16	0,28	0,23	0,16	0,58	0,15	0,18	0,22	0,091	0,155	0,209	0,205	0,19
TLV	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1

Fig. 1. Dynamics of Total Iron Content in the Water of Styr River

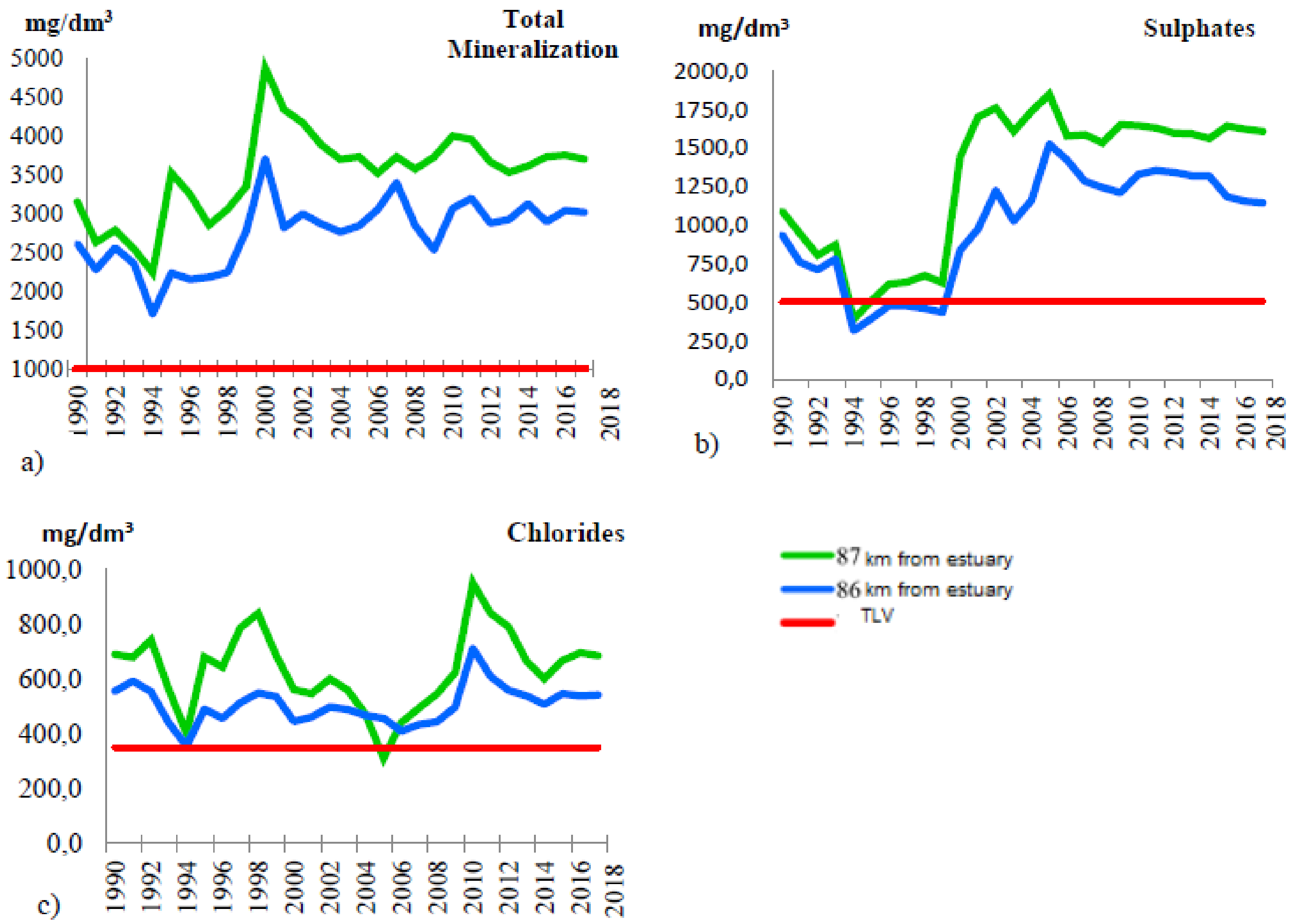


Fig. 2. Dynamics of Salt Block Substances Concentration in the Water of Molochna River

The integral indicator of the basin ecological condition is the quality of river water. The requirements of water protection legislation, taking into account the main provisions of the EU Water Framework Directive 2000/60/EC (WFD), are reflected in the project methodology "Environmental Assessment of Surface Water Quality by Relevant Categories". This technique identifies the main priorities in water protection activities and how to achieve good surface water status (Hrytsenko et al., 2012). It was developed following the Law of Ukraine "On Environmental Protection", Water Code of Ukraine, and the Resolution of Cabinet of Ministers of Ukraine as of March 19, 1997, No 244 "On Measures to Gradually Implement in Ukraine the Requirements of European Union Directives Norms and International and European Standards". The methodology considers the requirements of the WFD, the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), and some other international instruments. The role of biological analysis is increased in the design methodology, and the limits to determine water quality classes for individual indicators are set under the specifics of hydrochemical characteristics of watercourses (Osadcha et al., 2013).

The primary pollutants of Styr River belong to the trophy-saprobiological block and the block of substances of toxic and radiation action: nitrogen group (nitrite nitrogen - up to 5.8 TLV) and heavy metals (iron, copper, zinc, manganese - exceeding the corresponding TLV by tens of times). Their main sources are the following: municipal and industrial drainage, terrigenous drainage from agricultural lands, precipitation, and polluted inflow waters. The water quality of Styr River for the period 2000-2017 according to the contamination level corresponds to the II class of the 3-rd category; it is characterized as "good", according to the degree of saprobity - "β'-mesosaprobic", trophic - "meso-eutrophic". The complex indicator of ecological water quality of the I_E fluctuates within 2,5... 3,2, the average value of I_E=3,0 (Voznyuk and Kopylova, 2016). According to the EQI index (by water quality classes according to the EU WFD 2000/60/EC requirements) is classified as "moderate" (Directive, 2003).

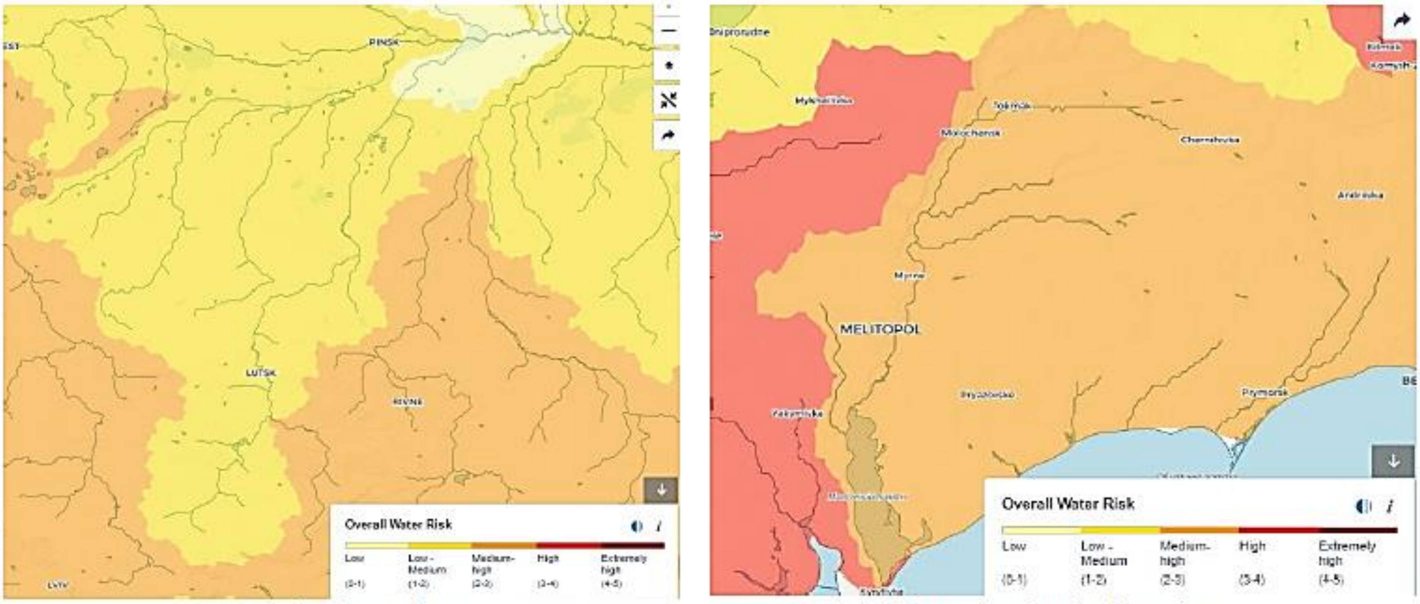
It is established that the main pollutants of the Molochna River also belong to the trophy-saprobiological block. The main pollutants of the Molochna River are nitrates and phosphates (water quality class V, according to (7). According to the nitrites and sulfates content, the water belongs to the IV class of the sixth category. Until 2000, according to the following indicators: ammonium nitrogen, phenols, biochemical oxygen consumption$_5$, synthetic surface-active substance, suspended solids, the river water belonged to the seventh category of V quality class. The complex indicator of ecological water quality of the Molochna River $I_{Eaver.}$ fluctuates within 4.9...5.6, I_{Eworst} = 5.7...6.55. The general dynamics to the insignificant improvement of water quality since 2000 was established. Water quality according to the pollution level belongs to the III class of the fifth category; it is characterized as "moderately polluted", according to the saprobity degree - "α'-mesosaproid", trophic - "ev-polytrophic". According to the EQI index, it is classified as "poor", which should be considered when planning the watercourse's economic use. In low-water years, there is a deterioration in the water quality of the Molochna River (Skyba and Voznyuk, 2018).

Thus, the water quality of Styr River is evaluated as "good", and Molochna River is "moderately polluted", reflecting the processes occurring in the river basins due to natural features and the level of anthropogenic load.
The World Resources Institute (WRI) interactive development allows using the Aqueduct geospatial database to determine the probability of water risk in any country in the world using the Aqueduct Water Risk Atlas. This, in turn, allows evaluating water risks and prospects for each basin (Table 1, Fig. 3-4), determining the strategy of water resources management, and identifying priority basins that require immediate implementation of the compensatory environmental measures (https://www.wri.org). The use of this approach allows taking into account water risks when developing a water management strategy. Table 2 shows the results of water risk evaluation in Styr and Molochna River basins

Table 2. Evaluation of Total Water Risk in the Basins of Styr and Molochna Rivers

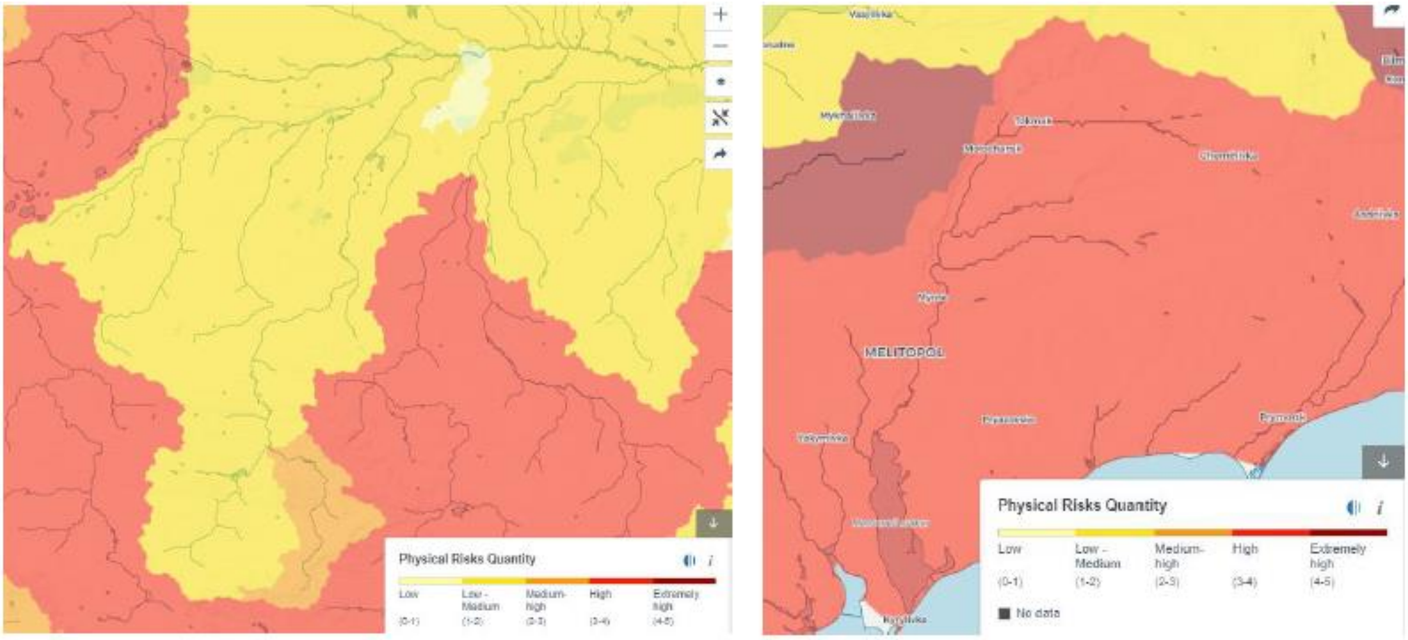
Indicator	Feature	Styr River basin (Polissya zone)	Molochna River basin (Steppe zone)
I. Physical risks quantity	Physical risks quantity measures risk related to low or high water amount by aggregating all selected indicators from the Physical Risk Quantity category. Higher values indicate higher water quantity risks.	1-2 low- medium	2-3 medium-high
Water Stress	Initial water deficit is measured by the ratio of total water collection to the available renewable surface and groundwater.	<10% low	3-4 high
Water Depletion	It is measured by the ratio of total water consumption to the available recovery sources.	<5% low	10-20% low- medium
Interannual Variability	This takes into account the variability of available water supply, considering the surface and groundwater are draining.	0.25-0.50 low-medium	< 0.25 low
Seasonal Variability	This considers the changes in average annual variability of water supply, considering the surface and groundwater are draining.	<0.33% low 0.33-0.66 low-medium	< 0.33 low
Riverine Flood Risk	The risk of flooding is evaluated considering the risk of territory flooding and the risk to the population.	6 in 1,000 to 1 in 100 high	2 in 1,000 to 6 in 1,000 medium-high
Coastal Flood Risk	The risk of flooding of the coastal areas is evaluated, considers the danger caused by the storm upsurges	0 to 9 in 1,000,000 low	0 to 9 in 1,000,000 low
Drought Risk	Probability of occurrence and drought consequences development	0.6-0.8 medium-high	0.8 – 1.0 high
II. Physical risks quality	Physical risks quality measures risk related to water that is unfit for use, by aggregating all selected indicators from the Physical Risk Quality category. Higher values indicate higher water quality risks.	4-5 extremely high	4-5 extremely high
Untreated Connected Wastewater	Wastewater discharge (primarily domestic), which does not reach the required level of treatment.	100% extremely high	100% extremely high
Coastal Eutrophication Potential	Eutrophication potential (CER), which takes into account the potential load of annual nitrogen, phosphorus, and silicon	0-1 medium-high	1-5 high
III. Regulatory and reputational risk	Regulatory and reputational risks measure risks related to uncertainty in regulatory change and conflicts with the public regarding water issues. Higher values indicate higher regulatory and reputational water risks.	1-2 low- medium	1-2 low- medium
Unimproved/No Drinking Water	Providing population with high-quality drinking water	<2.5% low	<2.5% low
Unimproved/No Sanitation	Available sewerage systems within residential areas, littering with solid waste, dumps, and landfills	2.5-5% low- medium	<2.5% low
Peak RepRisk Country ESG Risk Index	RepRisk index for different countries quantifies the economic risks associated with environmental, social, and managerial issues	60-75% high	60-75% high
Overall water risk	Overall water risk measures all water-related risks by aggregating all selected indicators from the Physical Quantity, Quality and Regulatory & Reputational Risk categories. Higher values indicate higher water risk.	1-2 low- medium	2-3 medium-high

Multifactor analysis with the presentation of an interactive GIS-map is based on three indicator blocks: physical risks quantity, physical risks quality, the regulatory and reputational risk with data averaging, and general definition of water risk in the studied basins. The extremum criteria were determined according to the physical risks quality block components, which is based on the compilation of two parameters untreated connected wastewater, coastal eutrophication potential. Among the natural and anthropogenic components included in the list of components for determining the overall water risk, the inflow of wastewater is a unique threat to the watercourse. It should be noted that a specific part of wastewater is discharged without treatment at all or insufficiently treated due to the obsolescence of technological systems of treatment facilities, primarily at the public utilities. As a result, there is an increase in the river water's nutrients content and acceleration of the eutrophication process. In total, the overall water risk for the basin of Styr River was rated as "low-medium", for Molochna River basin - "medium-high". A feature of this approach is predicting the development of environmental risks and the degree of water stress (Fig. 5). The probability of water stress for Styr River in 2030 and 2040 increases compared to 2020 and corresponds to "medium to high". While in, Molochna River basin, the probability of water stress is higher in 2030; the indicator increases to the gradation of "high", and in 2040 - "extremely high". Thus, the Molochna River basin, located at the Steppe zone of Ukraine, is more vulnerable to environmental risks.



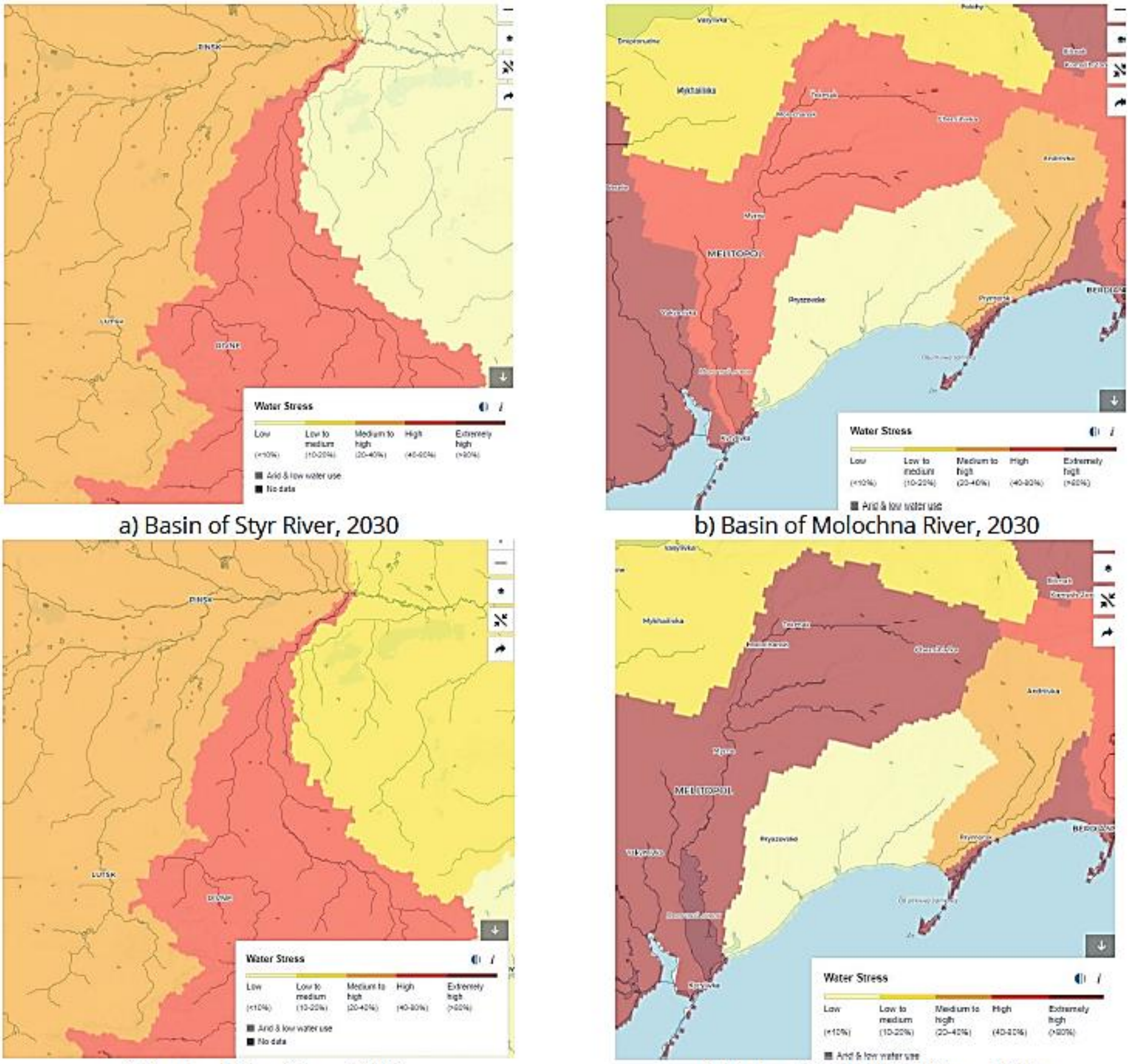
a) Basin of Styr River b) Basin of Molochna River

Fig. 3. Map-scheme. General Water Risk Formation Using the Interactive System Aqueduct Water Risk Atlas



a) Basin of Styr River b) Basin of Molochna River

Fig. 4. Map-scheme. Formation of Physical Risks Quantity



a) Basin of Styr River, 2030

b) Basin of Molochna River, 2030

c) Basin of Styr River, 2040

d) Basin of Molochna River, 2040

Fig. 5. Map-scheme. Probability of Developing Water Stress

Conclusions

The results of our research on the peculiarities of environmental risk formation in deteriorating river basins for different natural and climatic zones of Ukraine on the example of the rivers Styr (Western Polissya) and Molochna (Steppe zone) allowed us to draw several conclusions.

The river basins within different natural and climatic zones of Ukraine differ in surface runoff formation, hydrological, hydrochemical regimes, and the features of aquatic ecosystems. However, these are affected with the significant and similar anthropogenic load, resulting in conditions to form risks of the river basins' ecological status deterioration.

Establishing the level of anthropogenic load and evaluating the ecological condition of the Styr and Molochna River basins, carried out using the induction coefficient of anthropogenic load (ICAL), showed that in the basins of Styr and Molochna Rivers, there is an excessive use of land ("Land Use" subsystem) and water resources. ("River Draining Usage" subsystem), which determines the possibility of the formation of the environmental risk associated with the identified problems.

The coefficient of the development direction of degradation processes in the river basins that were established for the basin of Styr River KH=1.9 and Molochna River KH = 1.7 that indicates the urgent need to develop a set of environmental measures based on the analysis of the factors that minimized the negative effects of constant anthropogenic load and slow down the formation of environmental risks and their possible consequences. Thus, there is a probability of environmental risks in deteriorating these rivers' basins related to the development of degradation processes.

Because of water quality evaluation for Styr and Molochna Rivers, it was established that the primary water pollutants of the Styr and Molochna Rivers belong to the trophy-saprobiological block. For Styr River, heavy metal pollution (block of toxic and radiation substances) is also characteristic, but their high content is natural. The water quality of Styr River is evaluated as "good", and Molochna River is "moderately polluted", which is a reflection of the processes occurring in the river basins due to natural features and the level of anthropogenic load.

The interactive development of the World Resources Institute (WRI), using the Aqueduct geospatial database, allowed us to establish the probability of water risk in the Styr and Molochna River basins and predict the development of environmental risks and water stress. The probability of water stress for Styr River in 2030 and 2040 increases compared to 2020 and corresponds to "medium to high". The same as for the basin of Molochna River, the probability of water stress is higher in 2030; the indicator changed to "high", and in 2040 - "extremely high". Therefore, the Molochna River basin, which is located in the Steppe zone of Ukraine, is more vulnerable to the development of environmental risks.

It should be noted that anthropogenic factors under the influence of the ecological state of river basins in the zone of Western Polissya and Steppe zones of Ukraine significantly level the natural features of the processes in these basins and create the conditions for environmental risks with similar consequences.

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