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ORIGINAL PAPER
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EVALUATION OF WATER RESOURCES USE MANAGEMENT WITHIN THE RAUT RIVER BASIN (REPUBLIC OF MOLDOVA)

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ABSTRACT

Reason: The management of water resources in the Răut River Basin is of major strategic importance for the Republic of Moldova, taking into account that it includes the longest river flowing entirely within the country. The national legal context, through the Water Law, that partially transposes the EU Water Framework Directive and imposes the "Basin Principle" – makes it necessary to rigorously assess the use of water resources in order to ensure regional sustainability and alignment with the Sustainable Development Objectives and the Association Agreement with the EU.
Scope: The study aims to assess the use and management of water resources in the Răut River Basin, applying an interdisciplinary and integrated approach at the basin level. The central objective is to obtain a precise framework of the dynamics of water infrastructure and resources in the period 2016–2023, through analyzing key indicators: the length and density of the aqueduct network, the total volume of water supplied by consumer categories (population, budgetary institutions, economic agents). The methodology included descriptive statistical techniques, comparative analysis and cartographic methods (QGIS software) to identify trends and visualize spatial variations.
Results: The analysis has highlighted a deeply heterogeneous dynamics and a sharp polarization in the development of infrastructure. Although the total length of the aqueduct network increased by over 1320 km, the development was concentrated, with critical stagnation in certain areas. The total volume of water distributed almost tripled (from 9023.1 to 22,859.2 thousand m^3), supported by major projects. The structure of consumption changed radically: the share of the population fell below 5%, while the consumption of economic agents increased by over 11 times, reaching 54.2% of the total in 2023, with 94% concentrated in the Bălți municipality. These results underline the need for a strategic approach to reduce structural disparities and ensure equity in the distribution of water resources within the Răut River Basin.

Keywords: Răut River Basin, water resources management, basin principle, water supply infrastructure

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INTRODUCTION

Water resources are a vital component of planetary-scale ecosystems, interconnected with ecological and social systems. This interdependence highlights their vulnerability to global challenges such as climate change, population growth and economic development. They are also subject to major transformations, and external pressures may come from other regions or sectors, a phenomenon known as "teleconnections" (Hoff, 2010). Today, most countries face unprecedented pressure on freshwater resources, which are limited in space and time. Given the increasing demand for water, the natural flow of rivers is influenced by the land-use within the river basins, economic and technological development, legislative frameworks, governance and social constraints. During the 20th century, increasing water needs were managed through building massive infrastructures, such as dams, designed to increase the abstractions from rivers and aquifers. Currently, however, water resources in many river basins are completely or almost completely dedicated to human uses, leading to water quality degradation, threats to ecosystems and intense competition for resources (Molle et al., 2007).

A global study shows that, by 2050, over 80% of the Earth's surface will experience significant changes in hydrological behavior (Arnell & Gosling, 2013). These changes, resulting from variations in precipitation, include increases and decreases in the average annual river flow. Most climate models project an increase in runoff in regions such as Eastern Europe and a decrease in Central Europe and the Mediterranean region. Water resources in countries like Poland, with low river flows, are particularly vulnerable to such climate change. In this context, water retention in the soil and subsoil becomes an essential strategy to reduce surface runoff and increase exploitable resources, thus contributing to national water security (Michalczyk & Sposób, 2021). The implementation of the Water Framework Directive (WFD) has required integrated monitoring of chemical pollution and ecological status (Brack et al., 2007; 2009), revealing that, in addition to priority pollutants, unregulated substances also degrade aquatic ecosystems and limit economic uses (Chobotar et al., 2025). These chemical pressures are in addition to other major disruptions to the hydrological cycle, the most significant of which leads to the transformation of the natural landscape.

Responding to these climate and environmental challenges is central to the European agenda. The European Union's strategic vision to become the first climate-neutral continent by 2050 is set out in the EU Climate Law, and the "Fit for 55" legislative package, adopted in 2023, sets the path for reducing emissions by at least 55% by 2030. Although it mainly targets the energy and transport sectors, this package directly influences water management through energy efficiency objectives and the reduction of industrial pollution. Thus, the implementation of the Water Framework Directive (WFD) in partner states, such as the Republic of Moldova, can no longer be seen in isolation, but requires increased coherence with the broader commitments of the European Green Deal (European Commission, 2023).

Land-use changes, such as urbanization and agricultural area conversion, profoundly affect hydrological processes and water quality at different scales (Shiferaw et al., 2025). Sustainable management of river basins requires informed planning that recognizes the essential role of urban green spaces, forests and wetlands. These natural components act as mitigating factors, regulating surface runoff, maintaining water balance and improving water quality.

In the European context, a large part of the hydrographic network is made up of small bodies of water, including streams and small rivers. Around 80% of Europe's extensive river network is made up of small rivers, known by names such as springs, brooks or fordable rivers. These water bodies are essential for maintaining hydrological, chemical and biological processes, but their ecological status is poor in many places, mainly due to human activities. Their urgent protection is vital, and coordinated action with the EU water directives is essential to ensure a healthy and diverse aquatic environment (Kristensen & Globevnik, 2014). Studies in the field of participatory water management in Central and Eastern Europe

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emphasize the importance of rebuilding the links between small rivers and local society, highlighting the need to create better interaction between communities and these ecosystems (Ramos-Ribeio et al., 2014). Along with increasing water scarcity and competition between user sectors, the importance of a more efficiently use water has become increasingly important. A study focusing on the Maipo River Basin in Chile, for example, highlights the difference between physical efficiency (how much water is beneficially used) and economic efficiency (the highest economic value obtained from water use) (Cai et al., 2003). Both concepts are essential for effective water management at the river basin level.

River basins, including those of smaller watercourses, should not be regarded in isolation, but as an interconnected system. Human activities within these basins directly affect both the quality and quantity of water resources, while having a major impact on the social and economic conditions in the region (Moravcová et al., 2016). Integrated river basin management, which takes all these aspects into account, is essential to cope with extreme hydrological phenomena such as floods and droughts.

Integrated management of water resources and extreme hydrological phenomena is a priority at regional level, in line with sustainable development policy and European legislation (Ministry of Environment, Waters and Forests of Romania, 2023). The implemented strategic programs aim to guarantee water needs, reduce flood risk, and improve flash flood warning systems. In this regional and international context, the effective management of local river basins, such as the Răut River is of major importance. This basin, as a geographical and administrative entity, concretely illustrates the challenges and the applicable governance framework.

In the Republic of Moldova, the approval of the Water Law No. 272 (2011), launched a new principle of water resources management taking over the practices successfully implemented in European countries and applying the requirements set out in the framework directives of the European Union. Thus, the law partially transposes the Directive 91/271/EEC concerning urban waste water treatment, Directive 91/676/EEC on the protection of waters against pollution caused by nitrates from agricultural sources, and Directives 2000/60/EC establishing a framework for Community action in the field of water policy. Additionally, it incorporates Directives 2006/7/EC concerning the management of bathing water quality, 2007/60/EC on the assessment and management of flood risks, and 2008/105/EC on environmental quality standards in the field of water policy. By doing so, the law provides the necessary legal framework for the management, protection, and use of water resources.

In order to ensure the consistency of Water Law No. 272 (2011) with the European strategic and normative framework, over the years, amendments have been made to introduce new notions and concepts. Water resources are subject to general protection, but there are also specific regulations for certain categories. For example, aspects regarding drinking water are regulated by a special law, Law No. 182 (2019) on the quality of drinking water, which aims to protect human health against the harmful effects of drinking water contamination by ensuring its harmlessness and purity. Specific particularities regarding the exploitation of groundwater are found in the Subsoil Code, regulating the particularities of the exploitation of groundwater deposits. The legal framework regarding the regulation of the field of urban wastewater treatment is provided by Law No. 303 (2013) on the public water supply and sewage service (art. 22), which establishes the creation of the legal framework for the establishment, organization, management, regulation and monitoring of the operation of the public service for drinking water supply, technological water supply, sewage and domestic and industrial wastewater treatment under conditions of accessibility, availability, reliability, continuity, competitiveness, transparency, in compliance with quality, security and environmental protection standards.

Law No. 368 (2023) on Meteorological and Hydrological Activity establishes the legal framework necessary to prevent and minimize the impact of hazardous weather and hydrological phenomena

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on human life, property, and national security. Similarly, Law No. 119 (2004) on Plant Protection Products and Fertilizers sets the legal basis and state policy for the use of such substances, regulating their research, testing, import, and marketing to ensure safety for human health, livestock, and the environment. To implement these provisions, a secondary regulatory framework has been developed and approved, aligning national legislation with the aforementioned EU Directives were developed and approved (G.D. No. 199/2014).

Regulatory Framework and European Integration

The modernization of the water sector is driven by the strategic commitments of the Association Agreement between the European Union and the Republic of Moldova (2014), which establishes the legal basis for aligning national policies with European standards. The institutional framework is anchored in strategic national development programs and sector-specific environment plans (Law No. 315/2022). Consequently, the following Government Decisions (G.D.) ensure the transposition of Directive 2000/60/EC (the Water Framework Directive) into national legislation:

- G.D. No. 775 (2013) on the boundaries of river basin districts, sub-basins, and their respective mapping;
- G.D. No. 866 (2013) regarding the procedure for developing and revising River Basin District Management Plans;
- G.D. No. 867 (2013) approving the Model Regulation on the establishment and functioning of River Basin District Committees;
- G.D. No. 890 (2013) on environmental quality requirements for surface waters;
- G.D. No. 932 (2013) regarding the systematic monitoring and recording of the status of surface waters and groundwater.

It is currently imperative to analyze the status of aquatic resources, especially as the Republic of Moldova has committed to the National Accession Plan (approved via G.D. No. 306 (2025) regarding the National Program for the Accession of the Republic of Moldova to the European Union for 2025–2029). His commitment is further operationalized through the Environmental Strategy for 2024–2030 (G.D. No. 409 (2024), which establishes the long-term vision for sustainable resource management.

Within this framework, Cluster 4 (Green Agenda and Sustainable Connectivity) details the current situation and outlines strategic plans for environmental improvement. This process involves the continued transposition of the European legal framework and the adoption of international best practices to ensure the sustainable management of water resources.

Thus, the present study aims to assess the use and management of water resources in the Răut River Basin, applying an interdisciplinary and integrated approach at the basin level. The specific objectives involve analyzing the dynamics of the infrastructure (length and density of the aqueduct network) and water consumption patterns by user categories (population, budgetary institutions, economic agents) during the period 2016–2023 (National Bureau of Statistics [NBS], 2024a, 2024b). The working hypothesis posits that the infrastructural development was highly heterogeneous, and the consumption structure underwent a major transition towards the economic sector. The added value of the research lies in the integrated approach at the river basin level, providing the first comprehensive analysis that correlates these aspects for the Răut River Basin, constituting an essential empirical basis for the development of the management plan.

MATERIALS AND METHODS

This research approached an interdisciplinary framework that integrates geographic, statistical, and public policy analytical methods to assess the utilization and management of water resources within the Răut River Basin. The complete methodological flow followed is illustrated in detail in Fig. 1.

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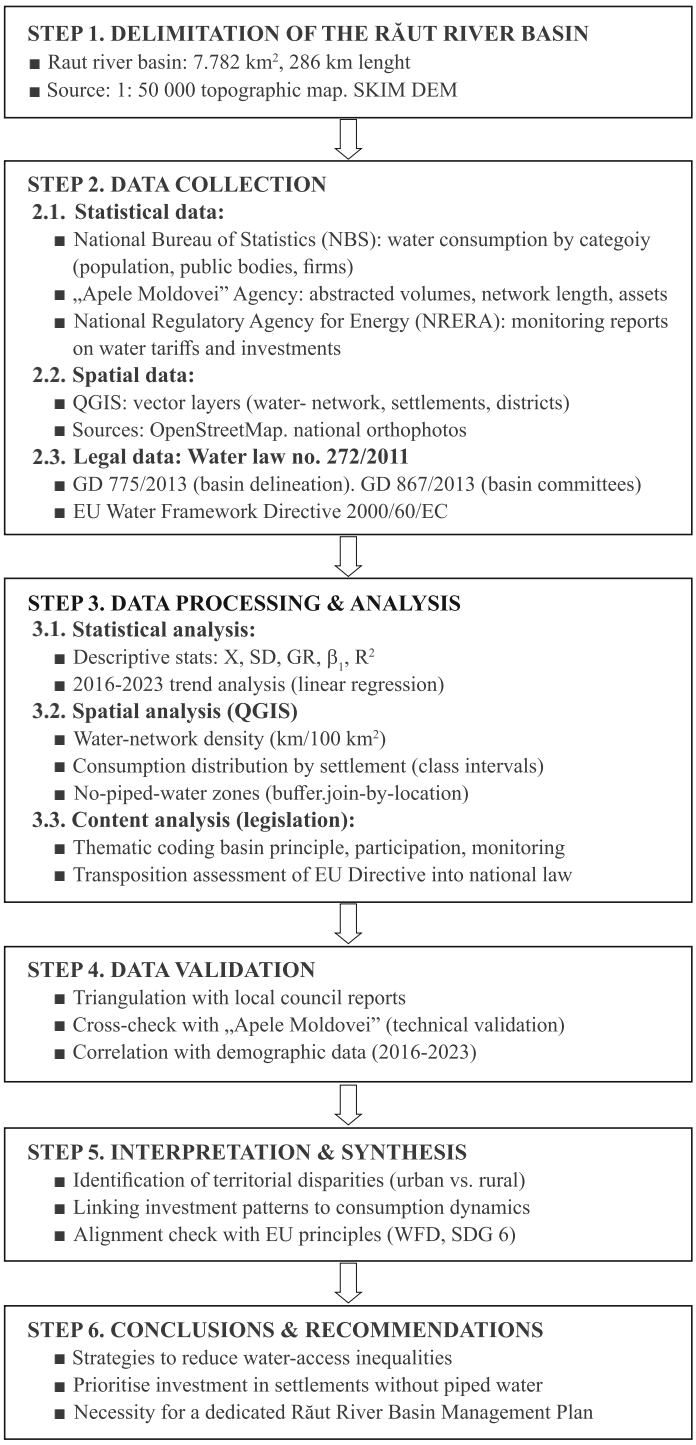

Fig. 1. Methodological framework for the analysis of water supply infrastructure and consumption dynamics in the Răut River Basin

Source: own elaboration.

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Study area: Răut River Basin

The study area is the Răut River Basin, the longest river flowing entirely within the territory of the Republic of Moldova. The basin is delimited according to Government Decision no. 775/2013, with an area of 7.782 km^2 and a length of 286 km. The river plays a crucial role in the country's hydrographic ecosystem, being located in a region characterized by limited hydrographic resources and problems of low flow and pollution (Fig. 2). From an administrative-territorial point of view, the Răut River Basin does not fit with the boundaries of the rayons but extends over the territory of 16 administrative units (either in whole or small parts), which complicates the analysis of statistical data aggregated per rayon. Therefore, in order to strictly align with the Basin Principle and for the clarity of the spatial analysis, the portions of the rayons that are within the basin have been called "administrative sectors" in the present paper. The study used the cartographic method (through QGIS software) to determine and illustrate the exact proportion of the basin area that belongs to each rayon. The distribution of the basin area by component rayons (sectors) is illustrated in Fig. 3, highlighting the rayons with the largest share within the basin area, and are Orhei (13.7%), Drochia (12.8%), Florești (10.7%) and Telenești (10.9%).

Management coordination is done at the level of the Răut Sub-Hydrographic Sub-Basin Committee (CSBH), according to G.D. No. 867 (2013), an essential consultative and coordination structure for ensuring collaboration between public authorities and water users.

As it was mentioned, the Republic of Moldova is considered a country with limited hydrographic resources, with the main source of surface water being the Dniester and Prut rivers. Small rivers in the country face problems of low flow and pollution, and a large part of the groundwater has a high degree of mineralization. Currently, the country has a quantity of water per capita much below the recommended international limit. According to the Food and Agriculture Organization (n.d.) AQUASTAT

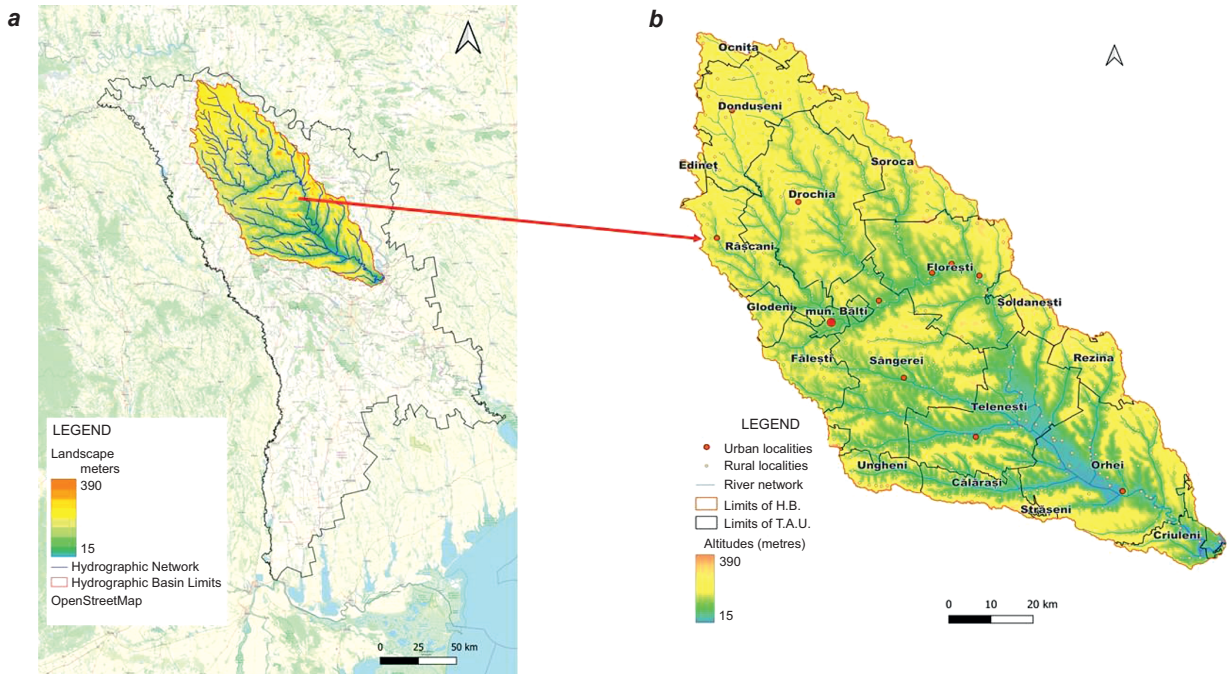

Fig. 2. Study Area – Răut River Basin geographical location: a) within Republic of Moldova, b) Territorial Administrative Units within Raut Hydrographic Basin

Source: own elaboration.

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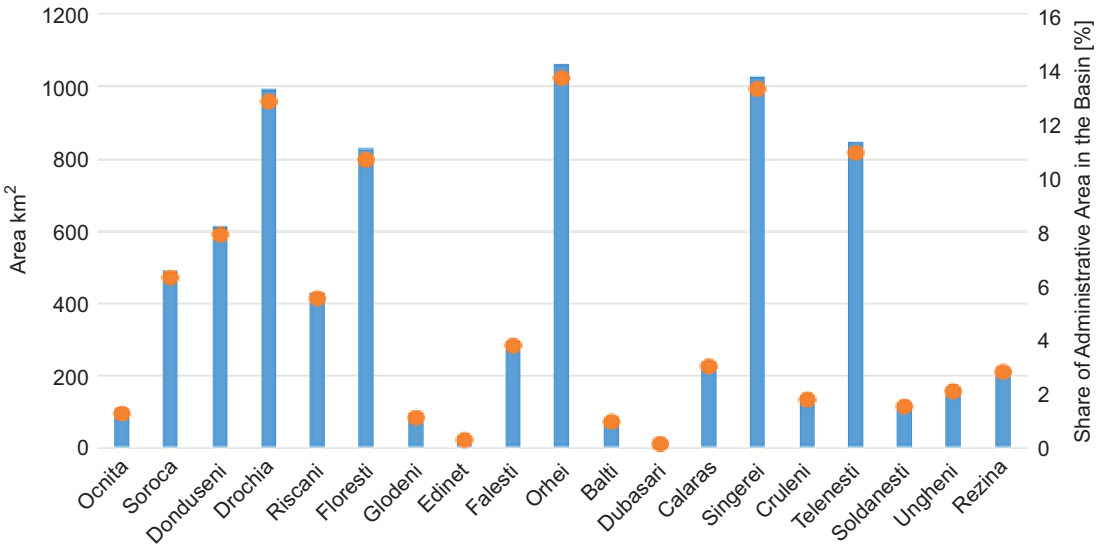

Fig. 3. Distribution of the Răut River Basin area by administrative-territorial units (rayons)
Source: own elaboration.

methodology, the threshold for water security is 1.700 m^3 per capita/year, while Moldova has only about 500 m^3. Regarding daily consumption, official data (NBS, 2025) for 2024 shows an average of 90 liters per capita, a slight increase from 85 liters in 2023 (National Agency for Energy Regulation [NAER], 2024), yet significantly below the European average of 120–150 liters. The Răut River, the largest tributary of the Dniester and the longest river flowing entirely within the territory of the Republic of Moldova (Fig. 3), plays a crucial role in the country's hydrographic ecosystem. Its hydrographic basin, with an area of 7.782 km^2, covers a considerable part of the Dniester Plateau and the Central Moldavian Plateau. The river is 286 km long and has an annual flow of 9.2 m^3/s (Cazac et al., 2007), rising from the Rediu Mare locality, Dondușeni rayon, and flowing into the Dniester near the Ustia village, Dubăsari rayon. The basin surface is plain, fragmented by valleys and ravines, and the hydrographic network is well developed.

Materials and information base

The study focused on the assessment of water resource use and management, applying the basin principle as the foundation of the integral analysis. The information base and materials included were:

1. Normative and strategic framework: This served as a governance analysis material, including the Water Law No. 272 (2011) (which partially transposes the Water Framework Directive No. 2000/60/EC), Government Decisions (G.D. No. 775 (2013), G.D. No. 867 (2013), G.D. No. 227 (2025) and national strategic documents.
2. Official statistical data: Published by the National Bureau of Statistics (NBS) and the "Apele Moldovei" Agency (Agenția "Apele Moldovei", 2023), with a focus on water consumption by sector and the activity of water supply systems.
3. Cartographic and geospatial data: Used for basin delineation and analysis of the spatial distribution of infrastructure.

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Research Methods

The applied research methods (detailed by stages in Fig. 1) included:

1. The basin approach: It constituted the central pillar, evaluating the physical-geographical and socio-economic interactions and the alignments with the sustainable development objectives (SDG 6).
2. Statistical method: It aimed at processing quantitative data by calculating descriptive indicators ($\bar{X}$, SD, GR) to establish the consumption profile, followed by the application of linear regression analysis to identify dynamic trends (2016–2023), the model performance being evaluated by the regression coefficient (β_1) and the coefficient of determination (R^2).
3. Cartographic method: QGIS software was used to create thematic maps, facilitating the spatial analysis of regional variations (e.g., water network density) and the identification of critical areas.
4. Analytical and deductive method: It allowed for content analysis of the governance framework, causal interpretation of factors influencing consumption, and formulation of strategic conclusions and recommendations.

RESULTS AND DISCUSSIONS

The data analysis for the period 2016–2023 highlights a complex dynamic in the development of water infrastructure and in the distribution of consumption in the Răut River Basin. In this context, the results are presented by examining key indicators, such as: the length and density of the aqueduct network, the total volume of water supplied by consumer categories and water consumption per capita (NBS, 2024a, 2024b).

Operating length of aqueducts and public water distribution networks (km)

The analysis evolution of the length in operation of the aqueduct network and public water distribution networks highlights a consolidated expansion effort at the level of the Răut River Basin, supported by central and local public authorities and development partners. The total length of the infrastructure increased from approximately 2760.8 km in 2016 to approximately 4084.7 km in 2023, marking an absolute increase of over 1320 km during this period (NBS, 2024a). This evolution is a direct indicator of infrastructure investments and the expansion of access to water services, aligning with the expansion targets established in the Water Supply and Sanitation Strategy 2014–2030 (Republic of Moldova, 2014). However, the increase was not uniform at the level of territorial units (rayons), with the total network expansion being strongly polarized and dependent on major efforts in only a few areas. Drochia rayon recorded the largest absolute expansion, with an increase of 258 km, followed by Singerei rayon (187.4 km) and Dondușeni (140.1 km). Notable increases of over 100 km were also recorded in Florești (134.4 km) and Soroca (137.9 km), consolidating the network in these areas. This expansion effort reflects the implementation of the "Basin Principle" and the water supply strategy also prioritized in the Prut River Basin Management Plan (Bejan et al., 2016). However, while the Prut is a transboundary river necessitating international cooperation, the Răut is the largest internal basin in Moldova. This internal status grants full national sovereignty over development projects but also places the entire responsibility for the sustainable management and technical integrity of these new networks on national and local authorities.

A detailed analysis at operator level (Table 1) highlights the discrepancy between the assumed modernization objectives and the actual financial execution capacity within the basin. Although the length of the networks is increasing, the rate of investment absorption remains critical for most license holders.

This asymmetry between the rapid pace of network expansion and the marginal rate of investment (which in critical centers such as Florești or Bălți has not even reached 3%) indicates a systemic vulnerability. Without a correlation between physical development and the capitalization capacity of operators, the long-term sustainability of water access in the Răut Basin remains precarious.

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Table 1. Comparative analysis of planned and implemented investments in water infrastructure at the level of operators in the Răut river basin (year 2023)

No.	License holder	Planned investments, thousand lei	Investments made, thousand lei	Achievement rate [%]	Status
1.	S.A. "Regia Apă Canal-Orhei"	3 111.8	2 174.7	69.9	The highest rate
2.	Î.M.D.P. "Apă-Canal" Sîngerei	353.7	151.7	42.9	Average achievement
3.	Î.M. "Gospodăria Comunală Rîșcani"	406.2	146.5	36.1	Below average performance
4.	Î.M. "Apă-Canal Dondușeni"	1 318.0	350.2	26.6	Implementation deficit
5.	Î.I.S. "Acva-Nord"	2 469.8	63.5	2.6	Very low achievement
6.	Î.M. Regia "Apă-Canal-Bălți"	8 809.7	226.2	2.6	Major discrepancy
7.	S.A. "Servicii Comunale Florești"	40 468.0	891.0	2.2	Major discrepancy
8.	Î.M. "Apă-Canal din Drochia"	-	-	-	Lack of reporting/ achievement
9.	Î.M.D.P. "Apă-Canal" Telenești	-	-	-	Lack of reporting/ achievement

Source: NAER (2024).

Moving from absolute progress to territorial efficiency, the comparative analysis of the *density of the functional aqueduct network* in the 19 territorial units of the Răut Hydrographic Basin, during 2016 and 2023, highlights a deeply heterogeneous development, with significant regional disparities.

The progress has been supported by substantial investments, primarily reflected in the increase of network density across 15 of the 19 analyzed sectors. While Orhei maintains a high baseline, the most pronounced density improvements occurred in sectors with extensive geographical areas, such as Florești (830.5 km^2), Drochia (996.1 km^2) and Sîngerei (1030.0 km^2). In these regions, infrastructure expansion led to a significant improvement in the ratio of pipeline kilometers per unit of area, ensuring a much more efficient territorial coverage (Fig. 4).

The density indicator reflects major discrepancies in the territorial coverage of the network between the analyzed units. Bălți municipality, with an area of 78.1 km^2, has the highest density (349.7 km/100 km^2) and a total network extension of 273.1 km. These values reflect an efficient concentration of resources. On the other hand, Glodeni rayon, covering an area of 89.4 km^2 in the Răut Basin, recorded the most dynamic increase in density, almost tripling its value from 30.6 to 95.5 km/100 km^2. Other rayons, which have recorded increasing values of the aqueduct network density are: Soroca from 3.8 to 31.9 km/100 km^2, Criuleni from 31.4 to 60.6 km/100 km^2 and Rezina from 20.3 to 45.8 km/100 km^2.

In direct contrast to the mentioned positive developments, the situation in the areas of the three territorial units partially included in the basin – Ocnița (98.8 km^2), Edineț (26.1 km^2) and Dubăsari (14 km^2) – is one of critical stagnation. This total lack of infrastructure development in the portions of the basin, despite the general growth trend, identifies them as neglected areas. An urgent investigation is needed to determine the specific barriers that have hindered progress, be they of a geographical, demographic, financial or investment prioritization nature.

The inequality in the development of the aqueduct network in the Răut River Basin is even more evident at the level of individual localities, where the density varies considerably, reflecting a pronounced

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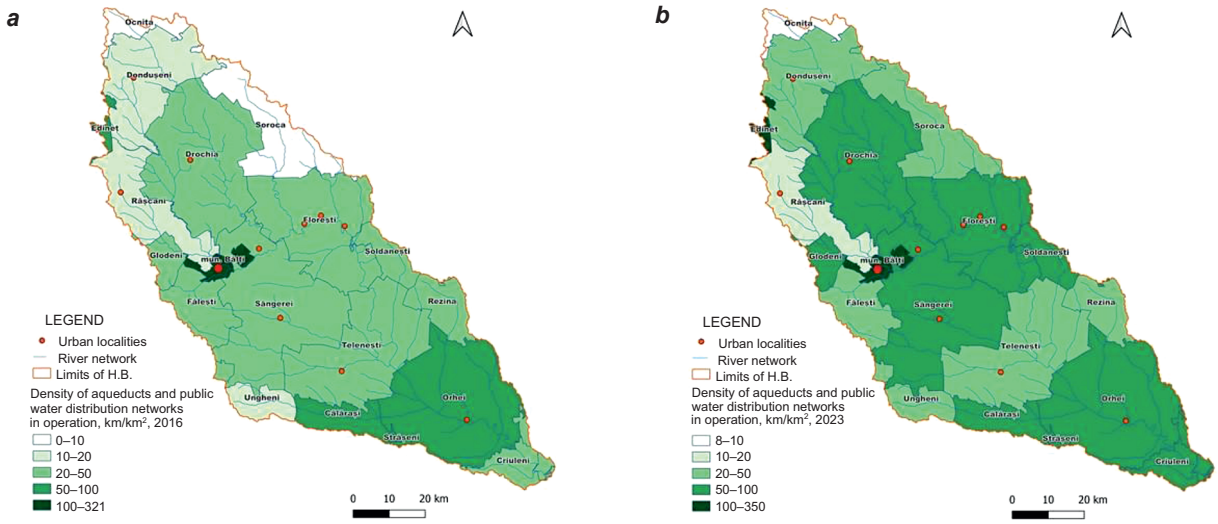

Fig. 4. Density of aqueducts and public water distribution networks in operation, km/km^2: a) year 2016, b) year 2023
Source: own elaboration based on NBS (2024a) data.

polarization. Of the total of 255 analyzed localities, the majority are facing the lack or very low density of infrastructure. An alarming situation is represented by the 63 localities that do not have an aqueduct at all, located mainly in rayons with critical stagnation, such as Florești, Drochia, Ocnița and Fălești.

Among the localities with infrastructure, the density distribution is uneven. A significant majority of 126 localities have a density of up to 0.1 km/km^2, including many localities in rayons such as Dondușeni, Glodeni and Fălești. The situation is gradually improving for only a small part of the total: 50 localities with a density between 0.1– 0.2 km/km^2, most of which are located in Orhei, Telenești and Sîngerei rayons. Of the 12 localities with a density of the aqueduct network varying between 0.2–0.5 km/km^2, most are located in the Telenești, Drochia and Sîngerei rayons. The maximum level of performance is reached by the 4 that exceed the threshold of 0.5 km/km^2, these registering the highest density values: Chișcăreni commune (0.67 km/km^2, Sîngerei rayon), Orhei city (0.82 km/km^2), Florești city (0.88 km/km^2) and Bălți municipality (0.99 km/km^2). This distribution highlights the deep disparities and the need for a strategic approach to ensure an equitable distribution of resources.

Structural analysis of water consumption

The analysis of water consumption supplied in the period 2016–2023 highlights a significant reorientation of demand from public to private consumers, a phenomenon closely linked to the socio-economic context of the region.

The total volume of water supplied has almost tripled from 9037.5 million m^3 to 22,954.7 million m^3. This increase was mainly driven by the consumption of economic agents, whose share increased from 12% in 2016 to 54% in 2023 of the totals, becoming the dominant category (Fig. 5) (NBS, 2024b).

This transition is also confirmed by the structure of water use in the Răut Basin, where in 2023 agriculture accounted for 10.1 million m^3 of the total 14.5 million m^3 of water used, while household needs required 3.4 million m^3 (NBS, according to data from the "Apele Moldovei" Agency). This distribution confirms that economic activities, especially agricultural ones, are the main driver of consumption within the basin. In contrast, although the absolute volume of households increased in the same period from 7338.5 million m^3 to 9820.6 million m^3, its share in the total decreased significantly, from 81% to 43%. A similar trend was also recorded by public institutions, when, there was

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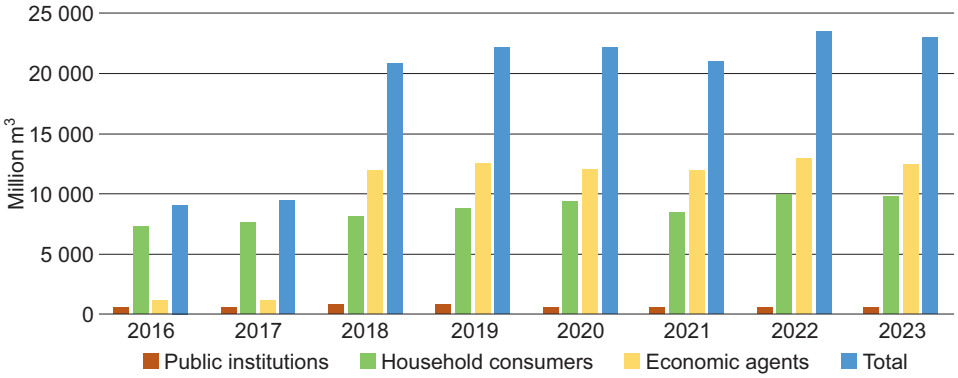

Fig. 5. Dynamics of water consumption distribution by consumer categories
Source: own elaboration based on NBS (2024b) data for the period 2016–2023.

a slight increase in consumption, the share of consumption decreased from 6.5% to 3%. This relative decrease illustrates that water demand in economic activities in recent years has far outpaced growth in other sectors.

Essentially, the consumption profile has radically shifted from one centered on household needs to one driven by economic activity. This transition highlights a significantly increased pressure on water resources from the productive sector and requires a reassessment of allocation policies to ensure equity and long-term sustainability.

The set of statistical indicators presented in Table 2 allows for a rigorous analysis of water consumption dynamics, volatility risk and the average annual trend for the period 2016–2023. Specifically, the value of the coefficient of determination $R^2 = 0.806$ calculated for the total water volume indicates a high predictability of the model, demonstrating that the identified trends have a solid statistical basis. These results are essential for forecasting future trends and for substantiating strategic management and investment decisions by sector, providing increased scientific weight to basin planning scenarios.

Table 2. Summary of statistical analysis (descriptive and trend) of water consumption by category (2016–2023)

Consumers categories	$\bar{X}$ (th. m^3)	SD (th. m^3)	GR (%)	β_1 th. m^3/year	R^2	Analytical conclusion
Budgetary institutions	658.66	53.1	15.65	12.33	0.208	Sector with the lowest risk of fluctuation (SD) small, indicating stable, predictable demand. The β1 trend is slow.
Population	9 694.55	823.8	33.88	311.66	0.505	Sector with the highest growth pressure (β1) positive and high, requiring priority investments in network expansion.
Economic agents	9 537.29	4 457.26	1 024.25	1 609.43	0.803	It has the highest average demand volume. Variations (SD, β1) are distorted by a major reporting methodological change in 2018.
Total	18 068.54	5 454.49	154.08	1 933.42	0.806	Data reflects systemic discontinuity (2017/2018); post-2018 (six-year) trend analyses should be used for economic planning.

Note: $\bar{X}$, SD, and β_1 are expressed in thousand m^3
β_1 and R^2 for Economic Agents incorporate the 2018 shift; economic planning should prioritize the stable trend observed in the 2018–2023 sub-period.
Source: own elaboration based on NBS (2024b) and the "Apele Moldovei" Agency (2016–2023).

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The analysis of the indicators ($\bar{X}$, SD, RC, β_1, R^2) reveals two clear dynamics:

1. Demand growth and investment priority: The household consumer sector represents the real engine of demand growth. It recorded a total growth GR = + 33.88% and a real annual trend of β1 = +311.66 thousand m^3. This dynamic imposes a strategic priority in investments aimed at expanding and modernizing networks for the population.

2. Stability and methodological anomaly: Unlike household consumers, budgetary institutions demonstrate the greatest stability and predictability, having the lowest Standard Deviation (SD) = 53.10 thousand m^3 and the lowest risk of fluctuation. In contrast, although economic agents have the highest average demand volume (X = 9537.29 thousand m^3), their growth indicators (GR and β_1) and volatility (SD = 4457.26 thousand m^3) are artificial and devoid of economic relevance. This is due to a major methodological discontinuity in reporting that occurred in 2018. In this context, for economic planning, trend analyses for this sector must be carried out on homogeneous post-2018 data.

This need to adapt planning strategies is also supported by the current technical context. The structural disparities identified in this analysis highlight a systemic inefficiency at the local distribution level, a fact confirmed by recently published data (NAER, 2025). Although at the national level the volume of water captured/procured remained relatively constant, reaching 100.5 million m^3 in 2023 (a slight decrease of 0.7% compared to 2022), the level of technical losses remains critical in major urban areas.

A major discrepancy is observed in the Bălți municipality: while the regional distributer Î.I.S. "Acva-Nord" demonstrates high technical efficiency, with losses of only 2.1% in 2023. At the same time, the urban distributor Î.M. Regia "Apă-Canal Bălți" is facing massive losses of 60.0%, continuously increasing compared to previous years (57.7% in 2021 and 59.7% in 2022, according to Table 4). This situation confirms that the increased wear and tear of distribution networks and the deficient tariff policy cancel out the benefits of access to an efficient water source, making a reform of infrastructure management imminent to ensure basin sustainability. In a regional context, a significant divergence is observed when comparing these findings with the Botna River Basin (Bejan et al., 2020). While the Botna basin is highly vulnerable to climate change and prolonged droughts due to its almost exclusive dependence on groundwater (over 85%), the Răut River Basin – and particularly the Bălți area – presents a strategic advantage through its mixed resource management and access to inter-basin transfers from the Dniester River. However, as the Bălți case demonstrates, this resource stability is undermined by infrastructure inefficiency, suggesting that climate resilience depends not only on water availability but also on the technical integrity of the distribution systems.

Total volume of water supplied by the public water supply system

The constant increase in the volume of water supplied in the Răut Basin, which increased its contribution to the national total from 10.7% to 23.5%, presented a deeply heterogeneous territorial dynamic. Bălți municipality recorded a significant jump, from 3.969 thousand m^3 in 2016 to 15.178 thousand m^3 in 2023 (NBS, 2024b). This evolution was largely supported by the commissioning of the Soroca-Bălți main aqueduct, which ensures the supply from the Dniester River through the I.I.S. "Acva-Nord". In parallel, a substantial expansion was recorded in the Soroca rayon, where the volume of water captured increased from 15.1 thousand m^3 to 440.7 thousand m^3, progress directly fueled by the extension of the aqueduct network from 18.4 km to 156.3 km. Florești rayon experienced a significant increase (from 625.1 to 953.8 thousand m^3), along with the Orhei (from 1512 to 2019.2 thousand m^3), Sîngerei (from 593.4 to 834.5 thousand m^3) and Telenești (from 667.3 to 962.9 thousand m^3) rayons, which reported constant increases in the volumes supplied.

The analysis of the share of each rayons reflects a sharp polarization: the Balti municipality has consolidated its dominant position, its share in the total basin increasing from 44% to 66.4% in 2023. This massive increase has led to a reduction in the

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percentage share of the other rayons, even in cases where the absolute volume has increased (Orhei decreasing to 8.8%, Telenești to 4.2%, and Sîngerei to 3.7%). This asymmetry reflects an inter-basin transfer (Dniester-Balți), dissociating the increase in urban consumption from the direct pressure on the Răut water resources.

In addition to the analysis of the delivered volumes, the analysis of the system's sustainability highlights a critical discrepancy between the transport and distribution phases of water. This increase in operating costs is closely linked to the technical inefficiency of local distribution systems, where water losses often exceed sustainable thresholds. While the regional "Acva-Nord" operates with high efficiency, reporting losses of only 2.0%, the urban distributors in the basin present a clinical picture of infrastructure wear. Thus, while in the Bălți municipality the approved technical losses reached an alarming level of 39.6%, other urban centers in the Răut Basin face similar challenges: in Florești the losses are 19.4%, in Drochia 15.1%, and in Sîngerei 10.7% (NAER, 2024).

A relatively more stable situation is observed in the Orhei municipality, where losses of 8.7% indicate a more efficient management of local networks. This technical disparity between modern main networks (such as Soroca-Bălți) and worn-out local systems partially cancels out the economic benefits of large volumes captured, representing the main barrier to ensuring a sustainable service and deepening the gap between capture capacity and final consumption billed to the population.

Total volume of water supplied to the population by the public water supply system

This major structural change was supported by investments in water infrastructure, which led to an increase in consumption in several districts. In addition to the general increase, the dynamics were heterogeneous, with notable variations between districts. Bălți municipality remained the largest consumer, with a volume that increased from 2839.8 thousand m³ to 3297.7 thousand m³ (NBS, 2024b). Substantial increases were also recorded in rayons such as Orhei (from 1337.4 to 1706.3 thousand m³), Sîngerei (from 518.7 to 741.3 thousand m³) and Telenești (from 605.4 to 843.1 thousand m³), demonstrating an expansion of distribution networks. A particular evolution was observed in rayons Soroca (from 14 thousand m³ to 173 thousand m³) and Șoldanesti (from 6.8 thousand m³ to 36.9 thousand m³), indicating an improvement in access to water services. This consumption dynamics is closely influenced by the economic accessibility of the service. Although consumption has increased, it remains conditioned by the tariff policy of the operators. The tariff for the population of Bălți municipality was adjusted to 11.23 lei/m³, a value that, although reflecting an upward trajectory compared to previous years, remains significantly lower compared to the rates applied in the rest of the region (NAER, 2024). In localities in Florești (27.64 lei/m³) or Dondușeni (36.37 lei/m³), high costs act as a deterrent, limiting household consumption, unlike urban centers where lower tariffs allow higher values of average annual consumption per person.

The dynamics of the distribution of the volume of water supplied to the population highlights a decrease in the number of localities without water supply services, from 106 localities in 2016 to 64 in 2023. The analysis shows that these localities remain grouped in concentrated areas: the northeast of the basin (Ocnița, Soroca, Drochia), the rural belt of Bălți (Fălești, Sîngerei, Drochia, Florești), the peripheral area of Florești rayon and singular rural areas in Ungheni, Telenești, Rezina and Șoldănești (Fig. 6).

The analysis for the period 2016–2023 shows a significant change in rural localities. The number of localities with very low consumption (below 10 m³/person) decreased from 191 to 117, while localities with medium and high consumption (above 20 m³/person) increased from 20 to 54. This suggests an improvement in infrastructure and quality of life. The highest values of consumption per capita were recorded in Râșcani (18.8 m³), Telenești (19.5 m³), Orhei (26.8 m³) and Bălți (35.5 m³). In contrast, rural localities in Ocnița, Edineț and Dubăsari maintained zero consumption, indicating a persistent lack of infrastructure. This situation aligns with regional

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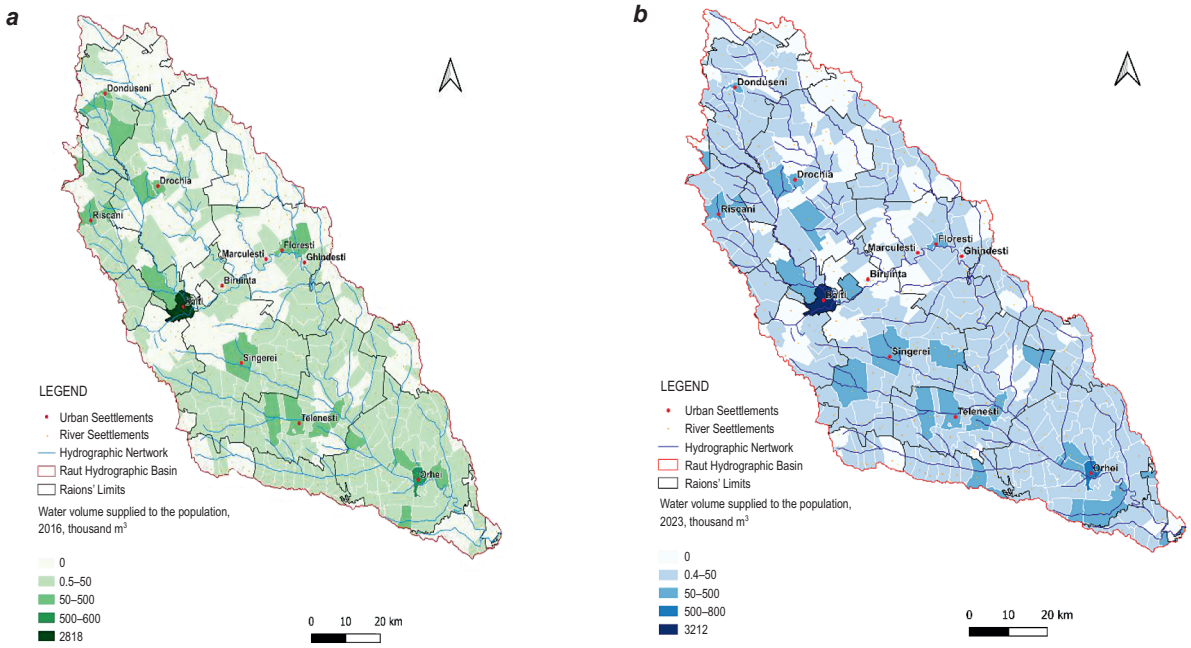

Fig. 6. Water volume supplied to the population, at commune level, in thousand m^3: a) year 2016, b) year 2023
Source: own elaboration based on NBS (2024b) primary data.

allocation priorities, where efforts are conditioned by the "number and size of urban and industrial centers" (Bacal & Mogîldea, 2021). This orientation explains why the fragmented rural systems in the Răut basin are disadvantaged, contributing to the deepening of the urban-rural divide.

Analysis of the dynamics of water consumption in the public and economic sectors

The dynamics of water consumption supplied to budgetary institutions in the Răut River Basin shows a significant increase in the period 2016–2023, the total volume increasing from 592.3 thousand m^3 to 684.7 thousand m^3 (NBS, 2024b). This evolution suggests an improvement in access to services and an increase in the number of users within public institutions in the region. This trend aligns with the general increase in water consumption observed in rural and urban areas in the same basin, indicating a general progress in infrastructure. Although at regional level the average growth of this sector is constant, certain territorial units have reported much faster dynamics; a telling example is the Rîșcani rayon, where the consumption of public institutions increased by 45%, significantly exceeding the general trend of the budgetary sector.

The consumption of water supplied to public institutions has registered a substantial increase in most rayons. The volume increased significantly in Florești, from 38.6 thousand m^3 to 47.3 thousand m^3 (+22.5%), in Rîșcani, from 24.7 thousand m^3 to 35.8 thousand m^3 (+45%), in Călărași, from 23.1 thousand m^3 to 40.2 thousand m^3 (+74%) and in Orhei, from 75.8 thousand m^3 to 134.6 thousand m^3 (+77.6%). Moreover, in rayons such as Drochia and Telenești, the volume of water supplied almost doubled, from 24.9 thousand m^3 to 47.8 thousand m^3 and, respectively, from 26.8 thousand m^3 to 52.7 thousand m^3. In contrast, only in Dondușeni rayon was a drastic reduction in consumption observed, from 48.4 thousand m^3 to 17.1 thousand m^3. This rapid decrease is attributed to the deep structural adjustments in the rayon, which include the optimization of the distribution network of public institutions (including

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those in local administration, health and education) and the impact of the demographic crisis on the number of beneficiaries, visible especially in the primary and secondary school network. In addition to demographic factors, the situation in Dondușeni rayon reveals a major management risk: excessively high tariffs can act as a critical disincentive, risking to determine institutions to abandon the centralized public system in favor of local groundwater sources. Such a transition not only affects the financial sustainability of the operator, but also makes it difficult to monitor water quality and the integrated management of basin resources. This general increase reflects an expansion of supply networks and a more intensive use of water in most institutions, demonstrating the state's strategic interest in ensuring access to water for public units as a priority. While the public sector has maintained a linear and relatively stable growth trajectory (+15.6%), highlighting a controlled expansion of public services, the private sector has experienced a radically different dynamic, characterized by an exponential explosion of consumption. This major discrepancy highlights the reorientation of economic priorities and resource allocation within the basin.

The dynamics of the volume of water supplied to other consumers by the public water supply system reflects a significant evolution of demand from the non-residential and non-budgetary sectors. This category mainly includes economic agents such as industrial enterprises and commercial units. The data show that this consumption has increased exponentially, from 1,107.4 thousand m^3 in 2016 to 12,449.9 thousand m^3 in 2023, representing an increase of more than 11 times. These dynamic highlights a considerable expansion of economic activities and a much more intensive use of water resources by economic agents. The growth was driven predominantly by an exponential increase in the volume of water supplied to businesses in Balti city, a major industrial center, while other districts saw modest increases or stagnation in consumption. In 2023, about 94% of the total volume of water supplied to businesses went to Balti, followed at a considerable distance by the rayons Soroca (2.1%), Orhei (1.4%) and Sîngerei (1.2%). At the same time, the rate of water volume supplied to economic agents in the Răut River Basin compared to the total for the republic increased from 5.4% in 2016 to 51.6% in 2023. The massive concentration of economic consumption in the Bălți municipality highlights an infrastructural paradox: although the city benefits from a modern regional water supply (Dniester), the economic benefits are partially cancelled out by the 60% technical losses in the urban network. This underlines the urgent need for attracting industrial investments to be correlated with the rehabilitation of distribution networks to ensure sustainable resource management.

Institutional governance and tariff regulation in the water supply sector

This intensive use of resources is closely linked to tariff policies. During 2023, the adjustment process was intense, with 8 requests for basic expenses and 56 requests for actual tariffs being examined. The Board of Directors of the National Agency for Energy Regulation of the Republic of Moldova issued decisions based on art. 7 of Law no. 303/2013, intervening in cases where local councils failed to adopt the determined tariffs. Data as of December 31, 2023 (Table 3) show how tariffs for non-households support the sustainability of operators managing these large volumes.

The data reflect a cross-tariff policy applied by most operators, where the non-household segment subsidizes household consumption to ensure the social accessibility of the service. This disparity between categories is a financial balancing mechanism, but which can generate barriers to local economic development. The presented tariff structure substantiates the economic mechanisms that determined the dynamics of non-residential consumption in the Răut Basin, highlighting a direct link between the unit price and the investment behavior of economic agents or the sustainability of budgetary institutions.

The exponential expansion of economic consumption in Bălți (+11 times) is supported by the most competitive non-household tariff in the region (23.64 lei m^3). Although it is higher than the household tariff, it remains below the tariffs in the Florești (35.09 lei/m^3) or Dondușeni (36.37 lei/m^3) rayons.

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Table 3. Tariffs approved by NAER for drinking water supply (lei/m³)

No.	License holder	Household consumers	Non-household consumers
1.	Î.M. Regia "Apă-Canal-Bălți"	11.23	23.64
2.	S.A. "Regia Apă Canal-Orhei"	17.36	26.10
3.	S.A. "Servicii Comunale Florești"	27.64	35.09
4.	Î.M. "Gospodăria Comunală Rîșcani"	16.25	29.01
5.	Î.M.D.P. "Apă-Canal" Sîngerei	18.41	16.24
6.	Î.M. "Apă-Canal din Drochia"	20.84	22.62
7.	Î.M. D.P. "Apă-Canal" Telenești	25.79	20.36
8.	Î.M. "Apă-Canal Dondușeni"	36.37	36.37

Source: NAER, 2024.

This competitive advantage explains why the Balti municipality concentrates 94% of the water volumes supplied to economic agents in the entire basin. The application of a high and uniform tariff of 36.37 lei/m³ has exerted major financial pressure on budgetary institutions (administrative, educational and health) in the Dondușeni rayon. The decrease in consumption in the Dondușeni rayon from 48.4 to 17.1 thousand m³ is the result of drastic optimization measures, forced by a tariff that considerably exceeds the regional average. Unlike the rest of the basin, in the Singerei and Telenești rayons a phenomenon of reverse subsidization is observed, with tariffs for non-households (16.24 lei/m³ and 20.36 lei/m³, respectively) being lower than those applied to the population. This tariff anomaly suggests a priority given to maintaining economic activity and public institutions, but puts additional financial pressure on households, reversing the traditional logic of social protection.

This strategy of maintaining prices below the threshold of 25–30 lei/m³ acted as a catalyst for consumption, facilitating significant increases in the region: institutions in the Rîșcani rayon recorded a 45% uptrend in consumption, while in the Drochia rayon a doubling in supplied volumes was attested. Thus, although the long-term sustainability of operators may be affected by low tariffs, in the short term, this policy favored the expansion of water resource use in the public and economic sectors.

CONCLUSIONS

1. Although the national regulatory framework has transposed the Water Framework Directive, implementation at the level of the Raut Basin remains partly declarative. The absence of a dedicated Management Plan and the limited functioning of the Sub-Basin Committee confirm the need to move from a reactive approach to a proactive planning, based on integrated monitoring of surface and groundwater sources.
2. The extension of the network by 1320 km has created a "hydro core" around the Balti municipality. It is essential to underline that this expansion is not based on the own resources of the Raut River, but on a massive inter-basin transfer from the Dniester River (through the Soroca-Balti aqueduct), which masks the local water deficit, but increases the vulnerability of the region to the integrity of long-distance transport systems.
3. There is a critical gap between the physical extension of the networks and the investment capacity of the operators (realization rate of only 36.4%). Massive losses in urban distribution indicate that large volumes captured from the Dniester are wasted in local wastewater systems, negating the economic benefits of water transfer.
4. The study identifies a paradigm shift: the reorientation from domestic to economic use. The tripling of the volume supplied was almost entirely supported by the demand of economic agents (54.2% in 2023). This explosion of economic consumption in urban nodes puts indirect pressure on groundwater and the basin ecosystems through the volumes of wastewater discharged.

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5. The disparity between the high urban consumption and the stagnation of the 63 rural localities (dependent on wells or depleting local groundwater abstractions) is alarming. High tariffs in rural areas (Dondușeni, Florești) act as a disincentive, deepening the inequality of access between localities connected to regional highways and isolated ones.
6. The increase in the basin's contribution at the national level (from 10.7% to 23.5%) indicates a systemic dependence of the Republic of Moldova on the performance of this area. Future management must balance the mix of resources (surface waters of the Răut, transfer from the Dniester and underground abstractions), in order to ensure water security in the context of climate change and the decline in the level groundwater.

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REFERENCES

Agenția "Apele Moldovei" ["Apele Moldovei" Agency]. (2023). *Rapoarte anuale generalizate (2016–2023) ale Asociațiilor Utilizatorilor de Apă* [*Generalized annual reports (2016–2023) of the Water Users Associations*]. (2023). [Unpublished materials]. Agenția „Apele Moldovei" (Republic of Moldova).

Arnell, N. W., & Gosling, S. N. (2013). The impacts of climate change on river flow regimes at the global scale. *Journal of Hydrology, 486*, 351–364. https://doi.org/10.1016/j.jhydrol.2013.02.010

Association Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and the Republic of Moldova, of the other part. Official Journal of the European Union, L 261, 30 August 2014. http://data.europa.eu/eli/agree/2014/492/oj

Bacal, P., & Mogîldea, V. (Eds.). (2021). *Starea și utilizarea sistemelor de aprovizionare cu apă și sanitație în ecosistemele urbane și rurale din Regiunea de Dezvoltare Nord a Republicii Moldova* [*State and use of water supply and sanitation systems in urban and rural ecosystems of the Northern Development Region of the Republic of Moldova*]. Institutul de Ecologie și Geografie.

Bejan, I., Bacal, P., Boboc, N., Angheluța, V., Țîțu, P., Stratan, L., & Iurciuc, B. (2020). *Planul de gestionare a bazinului hidrografic al râului Botna: Ciclul I, 2021–2027* [*River basin management plan of the Botna River Basin: Cycle I, 2021–2027*]. Agenția "Apele Moldovei". Chișinău.

Bejan, I., Boboc, N., Bacal, P., Angheluța, V., Tîțu, P., & Stratan, L. (2016). *Planul de gestionare al bazinului hidrografic Prut: Sumar executiv (Ciclul I, 2017–2022)* [*Prut River Basin Management Plan: Executive summary (Cycle I, 2017–2022)*]. Institutul de Ecologie și Geografie. Chișinău.

Brack, W., Klamer, H. J. C., López de Alda, M., & Barceló, D. (2007). Effect-directed analysis of key toxicants in European river basins. A review. *Environmental Science and Pollution Research International, 14*(1), 30–38. https://doi.org/10.1065/espr2006.08.329

Brack, W., Apitz, S. E., Borchardt, D., Brils, J., Cardoso, A. C., Foekema, E. M., Gils, J. van, Jansen, S., Harris, B., Hein, M., Heise, S., Hellsten, S., de Maagd, P. G., Müller, D., Panov, V. E., Posthuma, L., Quevauviller, P., Verdonschot, P. F., & von der Ohe, P. C. (2009). Toward a holistic and risk-based management of European river basins. *Integrated Environmental Assessment and Management, 5*(1), 5–10. https://doi.org/10.1897/IEAM_2008-024.1

Cai, X., Rosegrant, M. W., & Ringler, C. (2003). Physical and economic efficiency of water use in the river basin: Implications for efficient water management. *Water Resources Research*, *39*(1), 1013. https://doi.org/10.1029/2001WR000748

Cazac, V., Mihailescu, C., Bejenaru, Gh., & Gâlcă, G. (2007). *Resursele acvatice ale Republicii Moldova*

✉rodica.sirbu@icg.utm.md, ✉vadim.cujba@gmail.com

[*Water resources of the Republic of Moldova*]. Chișinău: Editura Știința.

Chobotar, V. V., Kopilevych, V. A., & Kravchenko, O. O. (2025). Assessment of Natural Water Resources in the Dniester River Basin for Fishery Purposes. *Journal of Water Chemistry and Technology*, *47*, 404–410. https://doi.org/10.3103/S1063455X25040010

Codul subsolului Nr. 3 din 02.02.2009 [Subsoil Code No. 3 of 02.02.2009]. Monitorul Oficial al Republicii Moldova, (75–77), art. 197 (Republic of Moldova).

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. (2000). Official Journal of the European Communities, L 327, 1–73. http://data.europa.eu/eli/dir/2000/60/oj

European Commission. (2023). *The European Green Deal: Striving to be the first climate-neutral continent*. European Union. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

Food and Agriculture Organization. (n.d.). *AQUASTAT – Global Information System on Water and Agriculture: Water use methodology*. Retrieved September 8, 2025, from https://www.fao.org/aquastat/en/overview/methodology/water-use

Hoff, H. (2010). Global water resources and their management. In *Global environmental change* (pp. 69–83). Springer Netherlands. https://doi.org/10.1007/978-90-481-8695-2_4

Hotărârea Guvernului Nr. 775 din 04.10.2013 privind hotarele districtelor bazinelor hidrografice și subbazinelor și hărțile speciale care se determină [Government Decision No. 775 of 04.10.2013 on the boundaries of the districts of the river basins and sub-basins] (2013). Monitorul Oficial al Republicii Moldova, nr. 222–227, art. 880 (Republic of Moldova).

Hotărârea Guvernului Nr. 866 din 01.11.2013 pentru aprobarea Regulamentului privind procedura de elaborare și de revizuire a Planului de gestionare a districtului bazinului hidrografic [Government Decision No. 866 of 01.11.2013 on the approval of the Regulation on the procedure for the development and revision of the Management Plan of the river basin district], Monitorul Oficial al Republicii Moldova, nr. 252–257, art. 972 (2013) (Republic of Moldova).

Hotărârea Guvernului Nr. 867 din 01.11.2013 pentru aprobarea Regulamentului-cadru privind modul de constituire și funcționare a comitetului districtului bazinului hidrografic (actualizată prin HG Nr. 586/2024) [Government Decision No. 867 of 01.11.2013 on the river basin district committee (amended by GD No. 586/2024)]. (2013). Monitorul Oficial al Republicii Moldova, nr. 383–385, art. 725 (Republic of Moldova).

Hotărârea Guvernului Nr. 890 din 12.11.2013 pentru aprobarea Regulamentului cu privire la cerințele de calitate a mediului pentru apele de suprafață [Government Decision No. 890 of 12.11.2013 on the approval of the Regulation on environmental quality requirements for surface waters], Monitorul Oficial al Republicii Moldova, nr. 262–267, art. 1006 (2013) (Republic of Moldova).

Hotărârea Guvernului Nr. 932 din 20.11.2013 pentru aprobarea Regulamentului cu privire la monitorizarea și evidența sistematică a stării apelor de suprafață și a apelor subterane [Government Decision No. 932 of 20.11.2013 on the approval of the Regulation on the systematic monitoring and recording of the status of surface waters and groundwaters], Monitorul Oficial al Republicii Moldova, nr. 262–267, art. 1047 (2013) (Republic of Moldova).

Hotărârea Guvernului Nr. 199 din 20.03.2014 privind aprobarea Strategiei de alimentare cu apă și sanitație (2014–2030) [Government Decision No. 199 of 20.03.2014 on the approval of the Water Supply and Sanitation Strategy (2014–2030)]. (2014). Monitorul Oficial al Republicii Moldova, nr. 72–77, art. 222 (Republic of Moldova).

Hotărârea Guvernului Nr. 409 din 12.06.2024 privind aprobarea Strategiei de Mediu pentru anii 2024–2030 [Government Decision No. 409 of 12.06.2024 on the approval of the Environmental Strategy for the years 2024–2030]. (2024). Monitorul Oficial al Republicii Moldova, nr. 325–328, art. 650 (Republic of Moldova).

Hotărârea Guvernului Nr. 227 din 23.04.2025 privind aprobarea Metodologiei de evaluare și clasificare a stării corpurilor de apă subterană [Government Decision No. 227 of 23.04.2025 on the approval of the Methodology for the evaluation and classification of the status of groundwater bodies]. (2025). Monitorul Oficial al Republicii Moldova, nr. 241–244 (Republic of Moldova).

Hotărârea Guvernului Nr. 306 din 2025 privind aprobarea Programului Național de Aderare a Republicii Moldova la Uniunea Europeană pentru anii 2025–2029 [Government Decision No. 306 of 2025 on the approval of the National Program for the Accession of the Republic of Moldova to the European Union

✉rodica.sirbu@icg.utm.md, ✉vadim.cujba@gmail.com

for the years 2025–2029]. (2025). Monitorul Oficial al Republicii Moldova (Republic of Moldova). https://www.legis.md

Inspectorate for Environmental Protection (IEP). (2024). *Protecția mediului în Republica Moldova: Anuarul IPM 2023* [*Environmental Protection in the Republic of Moldova: IEP Yearbook 2023*]. Chișinău: Ministry of Environment.

Kristensen, P., & Globevnik, L. (2014). European small water bodies. *Biology and Environment: Proceedings of the Royal Irish Academy*, *114*(3), 281–287. https://doi.org/10.3318/BIOE.2014.18

Legea Nr. 119 din 22.06.2004 cu privire la produsele de uz fitosanitar şi la fertilizanţi [Law No. 119 of 22.06.2004 on phytosanitary products and fertilizers]. (2004). Monitorul Oficial al Republicii Moldova, nr. 100–103, art. 510 (Republic of Moldova).

Legea apelor Nr. 272 din 23.12.2011 [Water Law No. 272 of 23.12.2011]. (2011). Monitorul Oficial al Republicii Moldova, nr. 46–49, art. 70 (Republic of Moldova).

Legea Nr. 303 din 13.12.2013 privind serviciul public de alimentare cu apă şi de canalizare [Law No. 303 of 13.12.2013 on the public water supply and sewerage service]. (2013). Monitorul Oficial al Republicii Moldova, nr. 302–304, art. 434 (Republic of Moldova).

Legea Nr. 182 din 19.12.2019 privind calitatea apei potabile [Law No. 182 of 19.12.2019 on the quality of drinking water]. (2019). Monitorul Oficial al Republicii Moldova, nr. 1–2, art. 2 (Republic of Moldova).

Legea Nr. 315 din 17.11.2022 privind aprobarea Strategiei Naţionale de Dezvoltare „Moldova Europeană 2030" [Law No. 315 of 17.11.2022 for the approval of the National Development Strategy "European Moldova 2030"]. (2022). Monitorul Oficial al Republicii Moldova, nr. 409–410, art. 758 (Republic of Moldova).

Legea Nr. 368 din 21.12.2023 privind activitatea meteorologică şi hidrologică [Law No. 368 of 21.12.2023 on Meteorological and Hydrological Activity]. (2023). Monitorul Oficial al Republicii Moldova, nr. 12–14, art. 30 (Republic of Moldova).

Michalczyk, Z., & Sposób, J. (2021). Water Resources in Poland and Their Use. In M. Zeleňáková, K. Kubiak-Wójcicka, & A. M. Negm (Eds.), *Management of Water Resources in Poland* (pp. 43–62). Springer. https://doi.org/10.1007/978-3-030-61965-7_4

Ministry of Environment, Waters and Forests of Romania. (2023). *Institutional Strategic Plan of the Ministry of Environment, Waters and Forests 2024–2027.* https://www.mmediu.ro/app/webroot/uploads/files/PSI%20MMAP%202024-2027.pdf

Molle, F., Wester, P., Hirsch, P., Jensen, J. R., Murray-Rust, H., Paranjpye, V., Pollard, S., & van der Zaag, P. (2007). River basins. In *Water for food, water for life: A comprehensive assessment of water management in agriculture*. International Water Management Institute (IWMI). https://archive.iwmi.org/assessment/Water%20for%20Food%20Water%20for%20Life/Chapters/Chapter%2016%20River%20Basins.pdf

Moravcová, J., Bystřický, V., Pečenka, J., Polenský, J., Pavlíček, T., Nováková, N., & Ondr, P. (2016). River basin management in the past and at present and its impact on extreme hydrological events. In T. G. Stoianov (Ed.), *Hydraulic structures and society* (pp. 1–18). IntechOpen. https://doi.org/10.5772/63398

National Agency for Energy Regulation of the Republic of Moldova (NAER). (2024). *Raport privind activitatea ANRE 2023* [*Activity Report 2023*]. https://www.anre.md

National Agency for Energy Regulation of the Republic of Moldova (NAER). (2025). *Raport privind activitatea ANRE 2024* [*Activity Report 2024*]. https://www.anre.md

National Bureau of Statistics of the Republic of Moldova (NBS). (2025). *Activitatea sistemelor publice de alimentare cu apă şi de canalizare în anul 2024* [*Activity of public water supply and sewerage systems in 2024*]. https://statbank.statistica.md

National Bureau of Statistics of the Republic of Moldova (NBS). (2024a). *Length in operation of aqueducts and public water distribution networks (km), by localities*, *2016–2023* [Data set]. https://statbank.statistica.md

National Bureau of Statistics of the Republic of Moldova (NBS). (2024b). *Volume of water captured and supplied by the public water supply system, by localities*, *2016–2023* [Data set]. https://statbank.statistica.md

Ramos-Ribeiro, R. R., Lewandowska-Czarnecka, A., & Czarnecki, A. (2014). Sustainable Analysis of Small Rivers with a Case Study in Poland. *Global Journals of Human Social Science: D Interdisciplinary, 14*(3), 53–57.

Shiferaw, N., Habte, L., & Waleed, M. (2025). Land use dynamics and their impact on hydrology and water quality of a river catchment: a comprehensive analysis and future scenario. *Environmental Science and Pollution Research International, 32*(7), 4124–4136. https://doi.org/10.1007/s11356-025-35946-y

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