Central European Journal of Geography and Sustainable Development
ISSN 2668-4322, ISSN-L 2668-4322
2023, Volume 5, Issue 2, Pages: 62-84
https://doi.org/10.47246/CEJGSD.2023.5.2.4

Regional Aspects of Water Use and Management in the Republic of Moldova

Daniela Burduja[1]*, Petru Bacal[1]
[1]Institute of Ecology and Geography, Chişinău, 1 Academiei Street, MD-2028, Republic of Moldova
danavirlan3@gmail.com (D.B.); pbacal16@gmail.com (P.B.)

Received: 20 November 2023; Revised: 27 December 2023; Accepted: 28 December 2023;
Published online: 28 December 2023

ABSTRACT: Water is the most important environmental factor that has a direct influence on the health of the population and the development of society. There is a clear need to establish the supply of the population with sufficient quantities of drinking water as a priority direction in state policy and actions for the health of the population in relation to the environment, in the context of sustainable management of water resources. Although, currently, the national balance of water reserves - water consumption in the Republic of Moldova is adequate in relation to the available resources, in the context of climate aridity and inefficient management of water consumption, this balance may be affected in the future. This research aims to analyze the dynamics and particularities of water resource abstraction and use in regional aspect, highlighting the branch structure and some limiting factors in determining the correct volume of water used. In the period 2003-2022 analyzed in this study, several periods with a maximum volume of water use (years 2007, 2009, 2020 and 2022) were highlighted as a result of droughts that affected the whole country. In all 6 development regions, most of the water used is abstracted from surface sources (85%). At district level, especially in rural localities, water use from underground sources, including wells and springs, predominates as a result of reduced access to public water supply systems. About 75% of the total volume of water used is attributed to technological uses. On the right side of the Dniester River, water is predominantly used for domestic (48%) and agricultural (38%) purposes.

KEYWORDS: Development Region, water use, technological, agriculture, household, Republic of Moldova

TO CITE THIS ARTICLE: Burduja, D., & Bacal, P. (2023). Regional Aspects of Water Use and Management in the Republic of Moldova. *Central European Journal of Geography and Sustainable Development*, *5*(2), 62–84. https://doi.org/10.47246/CEJGSD.2023.5.2.4

1. INTRODUCTION

At present, the consequences of climate change have already been felt in the Republic of Moldova, being one of the factors that triggered the process of water scarcity in some regions of the country. In addition, a number of non-climatic factors (increased pollution, development of industry and agriculture, etc.) are exacerbating the adverse effects of climate change on water resources, and the development of the national economy is also increasing demand for water. In this context, in order to develop and effectively implement policies and actions for the sustainable use and management of water resources, and to forecast water requirements in relation to available water resources, a comprehensive analysis of the specifics of water abstraction and use is needed. The research hypothesis is the insufficient knowledge of the aspects of water resources use and management, thus making it impossible to rationally exploit and protect them, which made it necessary to carry out this study, which provides a comprehensive scientific foundation of the current problem - water resources use and sustainable management, taking into account regional characteristics.

* Corresponding author: danavirlan3@gmail.com; Tel.: +373 787 63 810

In the Republic of Moldova, the most important water resources are surface waters, which are mainly represented by the transboundary rivers Dniester and Prut, which border the country to the west and east, respectively, and groundwater, with inland rivers being of only local importance. Even though the volumes of the main rivers are considerable, their use is limited due to several factors, such as depletion of water resources, long distance from the main rivers, declining water quality, etc (Bacal et al., 2022). On average, 85% of the water abstracted in the Republic of Moldova is from surface sources, this share being largely conditioned by the Cuciurgan Thermal Power Plant in the Transnistrian Development Region (DR), which abstracts more than 550 million m^3 of water from surface sources or 65% of the total volume of water abstracted in Moldova (849 million m^3) (Burduja & Bacal, 2022). However, most localities, especially rural ones, use predominantly groundwater. According to Van der Gun (2021), groundwater resources, at present, are not used sustainably, both due to natural factors and human activities, suggesting that options for restoring sustainability under favourable groundwater governance conditions should be identified. Transnistrian DR uses 85% of the total volume of water used in Moldova, of which more than 80% is for technological needs, which determines the branch structure of water use as a whole.

At the regional level, and in special at the district level, the specificities of water abstraction and use differ according to the natural conditions and the socio-economic situation. In this context, the aim of this research is to identify and analyse regional peculiarities of water resources use and management. The main topics covered in the paper are: 1) general characterization of water resources at regional level; 2) highlighting the sources of water abstraction; 3) analysing the dynamics of water abstraction and use; 4) highlighting the branch structure of water use at regional level; 5) carrying out SWOT analysis of water resources use.

2. LITERATURE REVIEWS

The water use is the aspect of water resources science that is best associated with human activity. The study of water use is essential for understanding human impacts on water resources and for assessing whether available surface and groundwater supplies are and will be adequate to meet future needs (National Research Council of USA, 2004).

The management and use of water resources in the Republic of Moldova is regulated by several legislative and normative acts: the Water Law No. 272 of 23.12.2011, the Law No. 440-XIII of 27 April 1995 on water, rivers and water basins protection strips, the Law No. 272 of 10 February 1999 on drinking water, the Government Decision No. 619 of 16 August 1994 "On the regulation of relations in the field of water management and rational use of water resources in the Republic of Moldova" (Burduja & Bacal, 2022).

There are many papers dealing with water resources in the Republic of Moldova, but most often them deal with water quality or hydrological aspects. A review of research in the field of water resources use and management has revealed that most often only certain aspects of water resources are addressed. In the Republic of Moldova there is already valuable research on: a) environmental protection management by Bacal P. (2010); b) surface water resources - Bejenaru & Melniciuc (2020), Cazac et al., (2010), Boboc & Bejan (2019), Jeleapov & Burduja (2020), and groundwater - Iurciuc (2017). The authors of this paper conducted research on the economic and geographical aspects of water abstraction and use at the level of country (Bacal & Burduja, 2018) , development regions (Burduja & Bacal, 2022; Burduja et al., 2020), as well as river basins (Bacal & Burduja, 2019, 2022). Economic analysis of water resources use is also included in the management plans of the Danube-Prut-Black Sea hydrographic district (Bejan et al., 2017), the Dniester hydrographic basin district (Governmental Decision of the Republic of Moldova no. 814, 2017), including the Prut, Camenca and Botna hydrographic basins (Bejan et al., 2016, 2019, 2020). Despite the existence of many valuable researches, at present, the researches on water resources assessment, use and management are rather fragmented and these aspects have not been studied as a whole, which also required the present study. Most often, only aspects of water quantity and quality are addressed, and water use and management are only superficially investigated.

An important aspect in the efficient valorisation of water resources is good water management. As a science, water management has developed with the complexity of problems related to the development of water users, changing climatic influences on water resources, and the timing and frequency of hydrological

droughts and floods. According to specialists Hâncu & Nițescu (2016), the rational use of water resources includes their integral use and the protection of their quality, thus ensuring the sustainable development of society, they also point out that water management is already becoming a kind of branch of economy. There are numerous works elaborated by Romanian researchers (Băloiu, 1971; Giurma, 2000) that approach water management from both quantitative and qualitative points of view, these studies representing an example, but also a good informational support in the analysis and appreciation of water management in the Republic of Moldova.

A great deal of effort is being made by experts in the field to raise awareness among the general public, decision-makers and the scientific community at large of the importance of a thorough understanding of water use (Caminola et al., 2023), and the factors that determine water consumption (Grespan et al., 2022). Water authorities face the challenge of ensuring that there is enough water to meet demand in the face of droughts, population growth and predictions of reduced supply due to climate change. To develop effective household demand management programmes, water managers need to understand the factors that influence household water use (Jorgensen et al., 2009). Reducing demand by improving water use efficiency requires understanding how water is used and how water savings can be achieved. In terms of water use and economic analysis of water use, in 2018 a group of researchers Aznar-Sánchez et al. (2018) conducted a survey of work in the field of economic analysis of water use, highlighting the evolution of research in this area globally.

In water consumption management an important role is played by water metering through public water supply systems. Access of the population to public water supply systems plays an important role both in knowing how water is used and in protecting water resources, so it is necessary for the population to understand the importance of water consumption monitoring meters. In this context, Madias et al. (2022), assessed and highlighted the extent to which consumers' perceived knowledge of water use influences their intention to adopt smart water meters, which provide very accurate data on the amount of water used in a household, concluding that informing the population has a positive impact on their understanding of the need for water use to be metered. In the Republic of Moldova, papers have already been developed addressing issues of the status and use of public supply systems (Bacal et al., 2022).

3. STUDY AREA

The Republic of Moldova is a landlocked country in Eastern Europe, bordered by Romania to the west and Ukraine to the north, east, and south. The capital city is Chișinău. The country spans a total of 33,483 km^2 and has a population of approximately 2.5 million. According to the Law no. 438 of 28.12.2006 on regional development, Development Region (DR) is the functional territorial unit that represents the framework for planning, evaluation and implementation of regional development policy. The Republic of Moldova comprises 6 development regions: North, Centre, Chișinău municipality, South, ATU Găgăuzia and Transnistria. From here arose the need for this study on the analysis of regional peculiarities of water resources use.

The Northern Region overlaps with the Northern Development Region and comprises 11 districts as well as the Bălți municipality. The Northern DR occupies >30% of the total area of the Republic of Moldova. The present population is 909 thousand inhabitants, including 127 thousand inhabitants - in Bălți municipality (National Bureau of Statistics, 2023). Most of the Northern DR (Dondușeni, Soroca, Drochia, Florești, Sângerei districts and Bălți municipality) lies within the boundaries of the Răut hydrographic basin (HB), while the western districts of the region are located in the Prut HB (Bacal et al., 2022).

The Central Region includes 13 districts that make up the Central DR, as well as the Chișinău municipality. The total area of the Central Region is 11.2 thousand km^2 or 33% of the total area of the Republic, with Chișinău municipality occupying 568 km^2. The population of the Central Region is ≈1.8 million inhabitants or about ½ of the total population of the Republic of Moldova, including 779 thousand in Chișinău municipality (National Bureau of Statistics, 2023). Districts in the central and eastern part of the region lie within the boundaries of the Dniester River basin and its tributaries, including the Răut hydrographic basin - Telenești and Orhei districts, Bâc HB - Călărași, Strășeni and Chișinău municipalities, Botna HB - Ialoveni district. Most of the territory of Ungheni, Nisporeni and Hâncești districts lies within the boundaries of Prut HB. And the eastern part of Hâncești rayon lies in the Cogâlnic river basin, which flows into the Black Sea.

The Southern Region of the Republic of Moldova covers an area of 9.2 thousand km^2, including the Southern DR - 7.4 thousand km^2 (22%) and the ATU Găgăuzia - 1.8 thousand km^2 (5.5%). The population of the Southern Region is 643 thousand inhabitants (21%), including the Southern DR - 494 thousand (17%) and ATU Găgăuzia - 150 thousand (4.8%) (National Bureau of Statistics, 2023). The Southern Region is part of the Danube-Black Sea Hydrographic Space, including the basins of the Ialpug (ATU Găgăuzia, Cantemir and Cahul districts), Cogâlnic (Cimişlia, Basarabeasca and Cauşeni districts), Sărata and Hadjider rivers (Căuşeni and Ştefan-Vodă districts). In the Dniester basin are the localities of the Ştefan-Vodă district situated in the Dniester River meadow, as well as most of the localities of the Căuşeni district situated in the basin of the Botna river, a tributary of the Dniester. In the Prut River basin is located the localities of the Leova district, as well as the localities of the Cantemir and Cahul districts located in the river basin.

The Transnistrian DR includes the districts of Râbniţa, Dubăsari, Grigoriopol and Slobozia, as well as the Tiraspol municipality. The unrecognised authorities of the breakaway region also control territories on the right side of the Dniester, including the Tighina municipality (Bender) and 6 communes in its vicinity. Therefore, the actual area of the Transnistrian DR is 4.2 thousand km^2 and the population 465 thousand. Thus, the share of the Transnistrian DR in the area and population of the Republic of Moldova is only 12% (Burduja & Bacal, 2022).

4. RESEARCH METHODS AND DATA

The scientific study's starting point was the analysis of existing studies related to the proposed research topic, thus placing this work at the interface of several scientific directions, which determined its complexity and importance. In general, the most commonly used methods were: statistical (for the assessment of water resources, accumulation and processing of statistical data on water abstraction and use, analysis of water supply systems and non-centralised water supply sources); comparative (for highlighting the peculiarities of water resources distribution, spatial and branch analysis of the volume of water abstracted and used); analytical (for the assessment of water resources and water abstraction and use systems, establishment of cause-effect relationships).

SWOT analysis method was applied to identify and discuss problems and opportunities related to water resources use and management. This method also allowed a comprehensive analysis of the current situation of water resources use and management, defining problems requiring the involvement of responsible institutions in the implementation of policies to improve the situation in this field.

The cartographic method is one of the basic methods in geographic research and is used in this study to spatially represent the weight of water abstraction sources and water use categories using ArcMap software.

Primary data can be used to determine water use through direct measurements, but due to the complexity and large study area secondary data was used. The acquisition of secondary data involves evaluation of the compilation and analysis of measured or estimated data submitted by water users to state agencies. In the present study, secondary data on water use was used, which is mirrored in the annual statistical reports obtained from the relevant authorities in the given area. The generalisation of these statistical data allowed a comprehensive analysis of several indicators directly related to water use and their dynamic management in order to highlight trends and evolution of these indicators. The period 2003-2022 was selected for the study, this being justified by the fact that in 2003 the Republic of Moldova returned to the Soviet system of administrative division into districts (32 districts, 13 municipalities and two recognized autonomous territorial units: ATU Găgăuzia and Transnistrian DR).

The information base included a series of statistical data from 2003 to 2022, which were selected, systematised and thoroughly processed from the annual reports on water management indices. The main data sources were: 1) Annual Reports of the Water Agency of Moldova (2003-2022); 2) Annual Reports of the Environmental Agencies and Inspectorates (2018-2021); 3) Reports of the National Bureau of Statistics (2022, 2023); 4) Reports of the State Hydrometeorological Service (SHS) (1977-2022).

5. RESULT AND DISCUTIONS

5.1. Water resources

Surface water resources. The hydrographic network of the Republic of Moldova consists of 4 drainage basins (Figure 1): the Dniester River, which accounts for 57% of the surface area; the Prut River, with about 24%; and the basins of the rivers flowing into the Danube and Black Sea, with 19%. The analysis of the water runoff balance on the territory of the Republic of Moldova during the period 1977-2022, showed a decreasing trend in the volume of runoff. The years 2011 to 2022 are classified as dry years. Since 2011, the volume of runoff on the territory of the Republic of Moldova has not been within the multi-year norm (State Hydrometeorological Service, 2019). All these years had runoff volume less than 2-3 km^3, and in 2016 the hydrological drought reached a record; the runoff volume was equal to 6.86 km^3 of water, which is almost half of the multi-year norm of 11.87 km^3; 2022 was an also a dry year, the runoff volume was only 7.32 km^3. Although, according to the available data (years 1977-2022) of the State Meteorological Service, the lowest volume of runoff was recorded in 2016, while the lowest amount of precipitation was recorded in 1990 and 2022 (13.0 km^2).

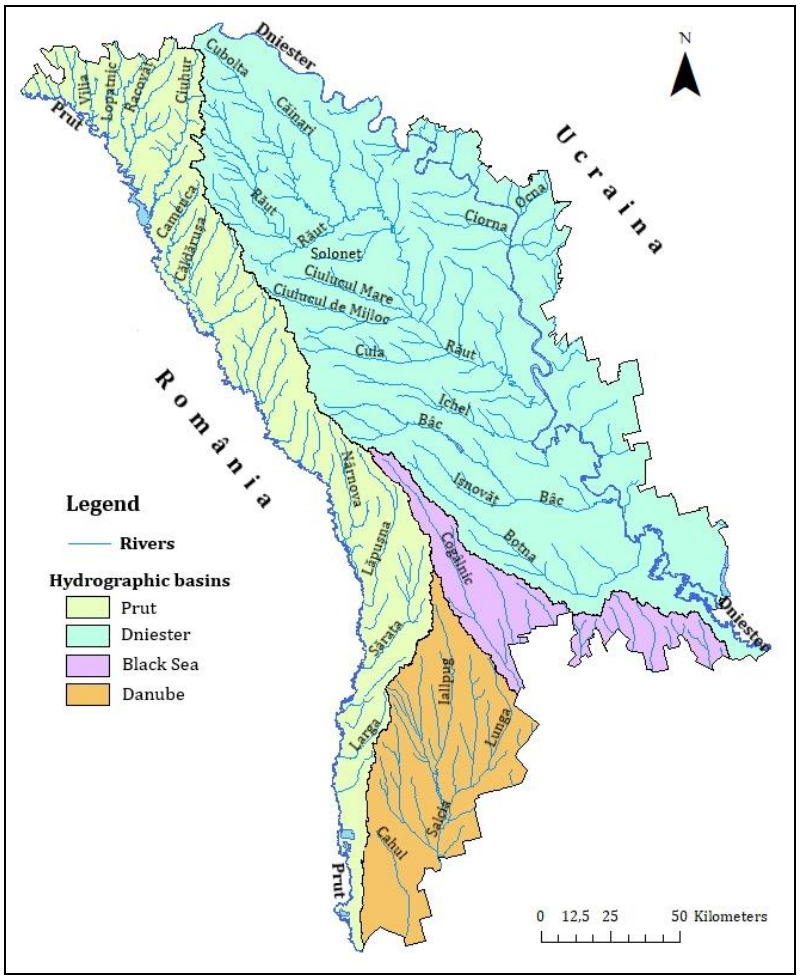


Figure 1. Hydrographic basins and main rivers of the Republic of Moldova.

The main surface water resources of the Northern DR are the Prut and Dniester rivers, which represent the eastern and western borders of the region. Within the boundaries of this region, the length of the Dniester River is 194 km and the basin area is 6,087 km^2, and the length of the Prut River is 232 km and the basin area is 3,964 km^2 (Jeleapov & Burduja, 2020). 36 rivers flow through the Northern DR. The Central DR has 57 watercourses stretching over a length of 1,955 km. The most significant surface water resources are available in the districts bordering the Dniester and Prut rivers. The river network of the Southern DR includes the Prut River basin, sectors of the Ialpug and Dniester rivers and the basins of the smaller Cogâlnic, Botna, Salcia, Cahul, Sărata and Hadjider rivers. Surface resources in the ATU Găgăuzia are limited, and most of the territory is in the Ialpug river basin (Figure 1).

At present, according to data from the Inspectorate for Environmental Protection (2021), there are 4,275 natural lakes and artificial basins in the Republic of Moldova with an area of about 43.1 thousand ha,

located and built on their courses and beds. About 57% or 2437 of the lakes are located in the Northern DR. More than ½ (52%) are allocated for fish farming, 1,660 lakes or 39% are allocated for general use. Only 6% are allocated for irrigation and only 139 lakes for recreation.

Groundwater resources. The renewable groundwater reserves of the Republic of Moldova are estimated at 3.478 million m^3/day. According to the State Balance of Reserves on 01.01.2020, the total number of approved natural mineral water reservoirs on the territory of the Republic of Moldova is 68 reservoirs (Bejan et al., 2017). The Northern Region has groundwater resources from 4 aquifer horizons, but the region's water supply is from the Badenian-Sarmatian Aquifer Complex and the Alluvial-Deluvial Aquifer Horizon. Exploitable groundwater reserves in the Northern DR represent only 17% of the total exploited groundwater reserves in the Republic. Most reserves are in Bălți municipality (89.3 thousand m^3/day) and in Râșcani (33.6 thousand m^3/day) and Fălești (28.1 thousand m^3/day) districts. The localities of the Central DR are also supplied with water mainly from the Badenian-Sarmatian aquifer complex and the Alluvial-Deluvial aquifer horizon. The Central Region has about 2/3 of the total groundwater reserves exploited in the country. The richest groundwater reserves are located in the districts bordering the Dniester River (Anenii Noi - 346.7 thousand m^3/day, Criuleni - 219.5 thousand m^3/day and Dubăsari - 200.2 thousand m^3/day). In the Southern Region groundwater supply is predominantly from the Alluvial-Deluvial aquifer and the Badenian-Sarmatian aquifer complex, but the available reserves are much lower - only 14.5% of the total of the Republic. The most important groundwater reserves are in Căușeni (57.9 thousand m^3/day) and Ștefan Vodă (51.6 thousand m^3/day) districts. On the territory of the Transnistrian DR are registered 76 underground water deposits from 4 aquifers (Burduja & Bacal, 2022).

5.2. Regional particularities of water resources abstraction

5.2.1. Water pumping stations and boreholes

Water pumping stations are a set of constructions, installations and machinery, which are used to bring water up to the required level of use. According to the National Bureau of Statistics, there are 1750 water pumping stations in the Republic of Moldova, including 1125 stations (64%) in rural areas and 615 stations (36%) in urban areas (Burduja & Bacal, 2022).

In Northern DR water is supplied by 350 pumping stations, of which about 230 stations (≈2/3 of the total number) are located in rural areas. Most stations are operated in the larger districts of the region, with a higher access of the population to public aqueducts, especially in rural areas, including Sângerei (67), Fălești (40), Râșcani (36) and Florești (32) districts. However, only about ¼ of the design capacity of these stations is used, which is explained by the advanced degree of wear and deterioration, and the significant reduction of water consumption in agriculture and industry.

In the Central Region there are about 850 water pumping stations or ≈50% of the total number in the Republic. There are about 650 water pumping stations in the districts of the Central DR, which is 37% of the total number in the Republic of Moldova (excluding the Transnistrian DR). The maximum number of pumping stations is found in the districts with the richest surface and groundwater resources, including Orhei (124), Telenești (87), Anenii Noi (86) and Criuleni (56).

In the Southern Region there are 562 (32%) water pumping stations, including 422 stations in the Southern DR and 140 stations in the ATU Găgăuzia. In rural areas ≈70% of the total number of water pumping stations in the region are located, including ≈80% in the Southern DR and 50% in ATU Găgăuzia. Most pumping stations are in districts with the maximum number of localities connected to public aqueducts, including Căușeni (91), Cimișlia (82). Cahul (80) and Ștefan Vodă (60).

Boreholes. According to data from the Inspectorate for Environmental Protection, there are 4970 boreholes on the territory of the Republic, of which only 53% are exploited. About 40-50% of the remaining boreholes are abandoned and remain without legal ownership. Most non-operated boreholes are located in the Northern DR, where they constitute 62% of the total number (1381) of boreholes in the Republic of Moldova (excluding the Transnistrian DR). In the Northern DR, most boreholes are located in the districts of Sângerei (183) and Râșcani (178). In the districts of Ocnița, Dondușeni, Drochia and Soroca, the share of non-operated boreholes exceeding 70% of the total number. The presence of a large number of non-operational boreholes indicate not only the inadequate quality of water resources, which prevents their use, but also the fact that their location was not correctly determined in time, depending on

several criteria. In the Central Region there are 2,166 boreholes, of which 1,693 are located in the districts of the region. About 62% of the total number are exploited. In the Southern Region, 1,423 boreholes were monitored in 2020, of which only 53% are exploited. Most boreholes are located in the ATU Găgăuzia (327) and the district of Căușeni (234). The Southern Region of the country is noted for the presence of the most exploited boreholes for domestic and curative purposes.

5.2.2. Wells and springs

Wells are extremely important to all societies. In many places wells provide a reliable and ample supply of water for home uses, irrigation, and industries. Where surface water is scarce, such as in deserts, people couldn't survive and thrive without groundwater, and people use wells to get at underground water (U.S. Geological Survey, 2018). In the Republic of Moldova, in 2018, more than 176 thousand wells were monitored by the Inspectorate for Environmental Protection. In the Northern DR there are about 107 thousand wells or 61% of the total number, of which most are concentrated in Edineț (15,898), Briceni (14,587) and Drochia (12,879) districts. In the Central Region there are 50.3 thousand wells or 28% of the total number of wells in the Republic. Most wells are located in Strășeni (6,911), Ungheni (6,112) and Orhei (5,485) districts. 18.7 thousand wells are located in the Southern Region, most of them in Leova (3,975), Căușeni (6,112) and ATU Găgăuzia (3,176) districts. In general, about 85% of the total number of wells are installed, but the situation by regions is different, in the Southern Region it is only 49%. Although the majority of wells and springs are arranged, they often do not meet sanitary and ecological standards. Official data are also influenced by the work of the environmental and health authorities in recording and monitoring springs and wells (Burduja & Bacal, 2022).

In the Republic of Moldova, 2,966 springs were monitored in 2018, 41.5% and 39% respectively were located in the Central and Northern Region, and only 234 springs in the Southern Region due to limited groundwater reserves in this region.

5.2.3. Volume of water abstracted in regional profile

The volume of water abstracted and used is conditioned by the water demand, the water resources available from surface and groundwater sources, and the technical and economic capacities for water abstraction, transport, treatment and use for various socio-economic activities (Bacal & Burduja, 2022). According to the data of the Water Agency of Moldova, in the analyzed period (2003-2022), the total volume of abstracted water was, on average, 849 million m^3, including 719 million m^3 (85%) - from surface sources and 130 million m^3 (15%) - from groundwater (Table 1, Figure 3).

Table 1. Volume and share of water abstraction by source and region.

TAU	**Average of years 2003-2022**							**2022**						
	total			**from surface**		**underground**		**total**			**from surface**		**underground**	
	million m^3	%		million m^3	%	million m^3	%	million m^3	%		million m^3	%	million m^3	%
North DR	**34,3**	**4.0[1]**	**21[2]**	**14,8**	**43[3]**	**19,5**	**57**	**36**	**4.3**	**23**	**18,7**	**52**	**17,2**	**48**
Soroca	10,2	1.2	6.4	9,0	88	1,2	12	15,3	1.8	10	14,4	94	0,9	5.9
Central DR	27,1	3.2	17	8,8	32	18,2	68	35,2	4.2	5	15	43	20,2	57
Chișinău	79,4	9.4	50	74,7	94	4,7	5.9	68,6	8.1	43	65,5	95	3,1	4.5
Central R.	107	12,5	67	83,6	78	23	22	104	12	65	80,5	77	23,3	22
Southern DR	15,4	1.8	9.6	6,5	42	8,8	57	15,7	1.9	10	6,3	40	9,4	60
Găgăuzia	3,7	0.4	2.3	0,4	10	3,3	89	4,1	0.5	3	0	0	4,1	100
Southern R	19,1	2.2	12	6,9	36	12,2	64	19,8	2.3	12	6,3	32	13,5	68
Dniester river right side	**160**	**19**	**100**	**105**	**66**	**54,7**	**34**	**160**	**19**	**100**	**106**	**66**	**54**	**34**
Transnistrian DR	**689**	**81**	**100**	**614**	**89**	**75,2**	**11**	**685**	**81**	**100**	**610**	**89**	**75,1**	**11**

[1] Share (%) of total volume of water abstracted in the Republic of Moldova, including Transnistrian DR

[2] Share of regions and municipalities in the total volume of water abstracted on the left and right sides of the Dniester river

[3] Share of surface sources in the total volume of water abstracted in the respective regions and municipalities.

Dnestrovsc	555	65,4	81	553	99,6	1,8	0.3	555	66	81	553	99,6	1,9	0,3
Tiraspol	26,7	3.1	3.9	1,3	4.9	25,4	95	26,7	3,2	3.9	1,3	4.9	25,4	95
Bender	24,1	2.8	3.5	0,45	1.9	23,7	98	24,1	2,9	3.5	0,49	2.0	23,6	98
Râbnița	14,6	1.7	2.1	7,7	53	6,9	47	10,7	1,3	1.6	3,8	36	6,9	64
Total RM	**849**	100		**719**	**85**	**130**	**15**	**845**	**100**		**716**	**85**	**129**	**15**

Source: Elaborated by the author according to data from the Annual Reports of the Water Agency of Moldova

More than 80% (689 million m³) of the total volume of water abstracted in the Republic comes from enterprises in the Transnistrian Development Region, including the Tighina municipality. The maximum volume of water in the Transnistrian DR is abstracted at the Dnestrovsc Thermo-Electric Power Station (555 million m³ or 81%), as well as in the cities of Tiraspol (26.7 million m³), Bender (24.1 million m³) and Râbnița (14.6 million m³). In the Transnistrian DR, from surface sources, are abstracted 614 million m3 of water or 90% of the total volume of water abstracted in this region, including 553 mil. m³ of water abstracted from the Dniester Liman for technology processes (water cooling) at the Dnestrovsc. Also, in the Transnistrian DR, on average 75.2 million m³ of water or 58% of the volume of water abstracted from groundwater sources in the Republic of Moldova is abstracted from underground sources (Table 1) and only 11% of the total volume of water abstracted in the region.

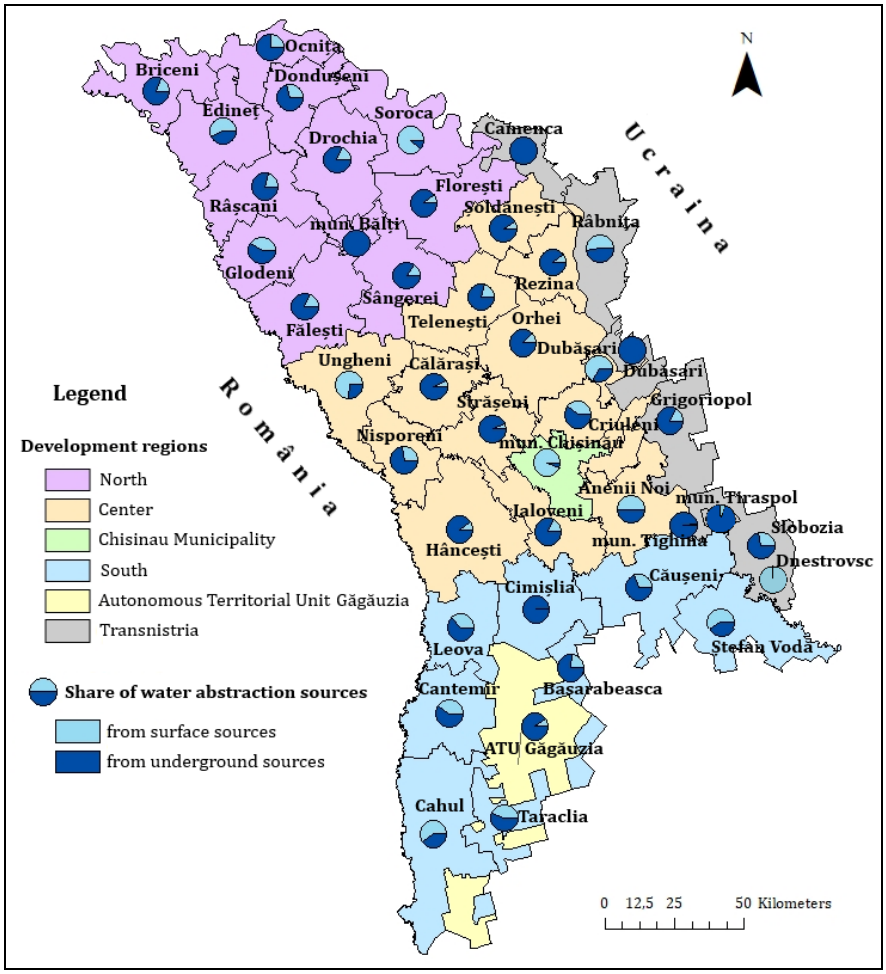
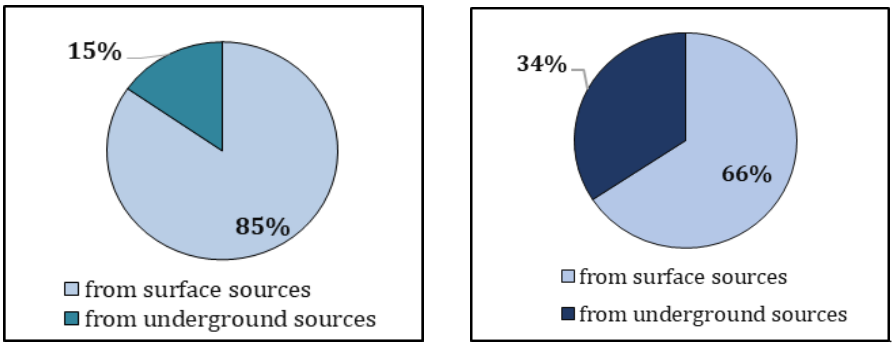


Figure 2. Share of water abstraction sources in the Republic of Moldova, average of years 2003-2022.
Source: Elaborated by the author according to data from the Annual Reports of the Water Agency of Moldova.

On the right side of the Dniester River, an average of 160 million m³ were captured, including in the Chișinău municipality - 79.4 million m³ (50%), in the Northern DR - 34.3 million m³ (21%), in the Central DR - 27.1 million m³ (17%), in the Southern Region - 19.1 million m³ (17%) and in the Southern Region - 19.1 million m³ (20%), of which in the Southern DR districts - 15.4 mil. m³ (10%) and in ATU Găgăuzia - 3.7 mil. m³ (2.3%). 105 mil. m³ or ≈ 2/3 of the total volume was captured from surface sources on average. At the

same time, more than 70% (74.7 mil. m3) of water from surface sources in the right side of the Dniester River was captured at the Vadul lui Vodă station in Chișinău municipality, 14.8 (14%) in the Northern DR, 8.8 mil. m³ in the Central DR (8%) and 6.9 mil. m3 (6%) in the Southern Region. On average, 54.7 million m³ or more than 1/3 (34%) of the total volume of water abstracted in the right side of the Dniester River was abstracted from underground sources. Underground sources predominate in the Central DR with more than 2/3 (67%) of the total volume of water abstracted and in the Southern Region with 64%, including in the Southern DR with 57% and in ATU Găgăuzia with 89% of the total volume of water abstracted.



(a) **(b)**

Figure 3. Share of water abstraction sources in the Republic of Moldova total (**a**) and without Transnistrian DR (**b**).

Source: Elaborated by the author according to data from the Annual Reports of the Water Agency of Moldova.

In the Northern DR, an average of 34.3 million m³ was abstracted, which represents 4% of the total volume of water abstracted in the Republic and 21% on the right side of the Dniester River, of which about 14.6 million m³is abstracted from surface sources. The predominant share (87%) of surface sources in the Soroca district is largely due to water pumping stations operated by ÎS Acva Nord in the city of Soroca. An average of 19.5 million m³ or 57% of the total volume of water abstracted in the region was abstracted from underground sources. Underground sources predominate by far in the Bălți municipality and in 9 of the 11 districts of the region, and the maximum share (≥80%) is found in the Bălți municipality (≈100%), as well as in the districts of Drochia, Florești and Fălești (Figure 2).

In the Central DR, an average of 27.1 million m³ was abstracted, which is 3% of the total volume of water abstracted in the Republic and 17% on the right side of the Dniester River. Maximum volumes of water were also abstracted in districts with direct access to the Dniester and Prut rivers, including Anenii Noi (4.2 million m³), Orhei (3.9 million m³) and Ungheni (3.2 million m³). An average of 8.8 million m³ or 32% of the total volume of water abstracted in the region was abstracted from surface sources. Surface sources predominate only in the riparian districts. From underground sources 68% of the total volume of water abstracted in the region was abstracted.

In the Chișinău municipality, an average of 79.4 million m³ were abstracted, which represents 9.4% of the total volume of water abstracted in the Republic and 50% in the right side of the Dniester River. From surface sources, an average of 74.7 million m³ or 71% of the surface water abstracted on the right side of the Dniester River was abstracted and 94% of the total volume of water abstracted.

In the years 1990-2002, as a result of the deep social and economic crisis, which affected in particular agricultural and industrial enterprises, there was a more than fourfold reduction in the total volume of water abstracted, or from about 4 billion m³ to about 900 million m³, including the volume of water abstracted from surface sources - 4.4 times (from 3.6 billion m3 to about 730 million m³). Due to the significant decrease in state control in the field of natural resource use and protection, the record of the volume of water abstracted and used, especially in agriculture and mining is of a formal nature. In addition, a large part of the rural population, especially in the Northern DR, is supplied from wells and springs and the water used is not subject to recording and treatment (Burduja & Bacal, 2022).

In the period 2003-2022, the total volume of abstracted water has an oscillating evolution (Figure 4), marked both by the economic evolution and meteo-climatic peculiarities, as well as by the evolution of data from the Transnistrian DR. At the same time, the data of the Moldovan Water Agency for the cities of the region are almost identical throughout the period analyzed, except for the the Râbnița city. This would

not correspond to reality, if we take into account the reduction in the volume of industrial and agricultural production and the number of population. At the same time, according to data from the Tiraspol Statistical Service, the total volume of water abstracted after 2010 is much higher than indicated in the reports of the Water Agency of Moldova, including 958 million m³ in 2010, 861 million m³ in 2015 and 923 million m³ in 2019. In this context, it is necessary for the Chișinău and Tiraspol authorities responsible for water resources management to develop a common platform of the Water Information System, coordination and implementation of measures for sustainable development and protection of water resources (Burduja & Bacal, 2022).

The negative trend is due to the reduction in the volume of water abstracted in the Southern DR (1.3 times). At the same time, the volume of water abstracted in the Central DR increased by 34%, due to the faster expansion of rural public aqueducts and the partial restoration of irrigation systems in the districts bordering the Dniester River. A multiple reduction in the volume of water abstracted was observed in the Bălti municipality (due to the connection to the Soroca-Bălți aqueduct in 2006), as well as in the Căușeni (-60%) and Edineț (2.0 times) districts.

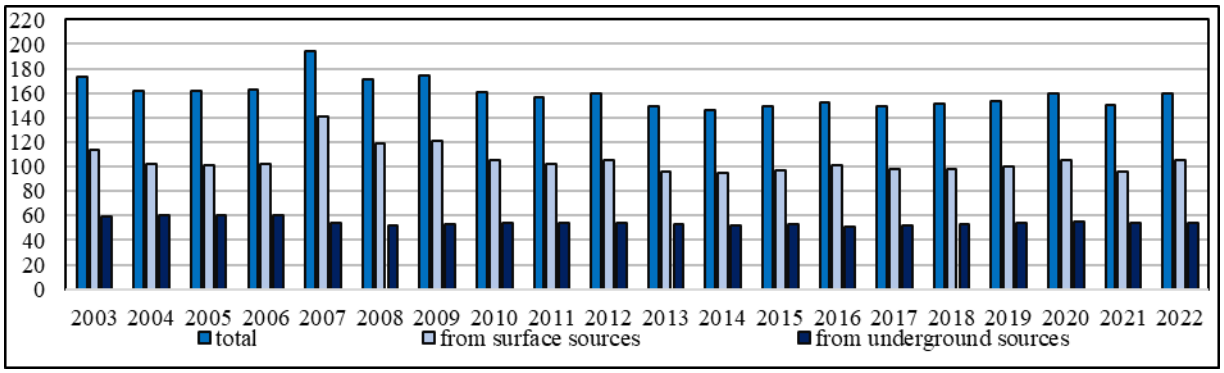


Figure 4. Dynamics of water abstraction volume in total and by abstraction source in the Republic of Moldova (without Transnistrian DR), in million m³.

Source: Elaborated by the author according to data from the Annual Reports of the Water Agency of Moldova.

The dynamics of the volume of water abstracted from surface sources is similar to that of the total volume of water abstracted, with a general downward trend of 7%, which is due to the Chișinău municipality (by ≈1.2 times or by ≈15.1 million m³) and the Southern Region (by 2 times or by 6.2 million m³). At the same time, the significant increase in the volume of water abstracted from surface sources is recorded in the Northern DR (by 1.8 times) and the Central DR (by 1.5 times), which is due, as mentioned, to the increase in the volume of water abstracted by the Northern Acva State , the increase in water abstraction and distribution capacities at large export-oriented agricultural enterprises, as well as the restoration of irrigation systems in the districts bordering the Dniester river in the Central RD, due to the exploitation of the opportunities offered by the "Compact" Programme for the rehabilitation of irrigated land.

In 2022, 845 million m³ of water were abstracted, including 686 million m³ in the Transnistrian DR. 160 million m³ were abstracted on the right side of the Dniester River, of which 68.6 million m³ (43%) in the Chișinău municipality, 36 million m³ (22%) in the Northern DR, 35.2 million m³ (22%) in the Central DR, 15.7 million m³ (10%) in the Southern DR and 4.0 million m³ in ATU Găgăuzia (2.5%). From surface sources, 715 million m³ or 85% of the total volume was captured. The share of surface sources in the total volume of water abstracted from surface sources in the year 2022 has higher values compared to the average of the analyzed period, due to the increase in the volume of water used for irrigation. In the Southern DR, the share of surface sources is 3% lower than the period average. 130 million m³ or only 15% of the total volume was abstracted from underground sources.

5.3. Regional and branch peculiarities of water resources use

During the period under review, the total volume of water used in the Republic of Moldova averaged 785 million m³, of which 670 million m³ (85%) in the Transnistrian DR. Similar to the volume of abstracted

water, the maximum volume of water used in the Transnistrian DR is in the city of Dnestrovsc (555 million m³), of which 99.5% is used at the Dnestrovsc Thermo-Electric Power Station for technological cooling processes, as well as in the cities of Tiraspol and Bender (about 22 million m³ each), Râbnița (13.4 million m³).

On the right side of the Dniester River, an average of 116 million m3 were used, including 50.2 million m³ (43%) in the Chișinău municipality, 25.1 million m³ (22%) in the Central Region, 24.2 million m³ (21%) in the Northern Region, and 16.1 million m³ (14%) in the Southern Region (Table 2).

Table 2. Volume and share of water use by regions and use categories (average years 2003-2022).

TAU	Total			Household		Technological		Agriculture					
								Total		Regular irrigation		Other	
	million m³	%	%	million m³	%	million m³	%	million m³	%	million m³	%	million m³	%
Northen DR	24,2	3.1	21	6,7	27	3,3	14	14,2	59	3,9	16	10,2	42
Soroca	5,1	0.6	4.4	3,4	67	1,5	29	0,17	3.3	0,007	0	0,16	3
Central DR	25,1	3.2	22	4,8	19	1,3	5.2	18,4	75	5,8	23	12,9	51
Chișinău	50,2	6.4	43	41	82	8,5	17	0,56	1.1	0,2	0	0,33	1
Central R.	75,3	9.6	65	46	61	9,7	13	18,9	25	6	8.0	13,2	18
Southern DR	13,6	1.7	12	2,8	21	0,7	5.1	9,9	73	3,3	24	6,6	49
Găgăuzia	2,6	0.3	2	0,9	35	0,12	4.6	1,4	53	0,2	7.7	1,1	42
Southern R	16,1	2.1	14	3,8	24	0,8	4.8	11,3	70	3,5	22	7,7	48
Dniester river right side	**116**	**14.7**	**100**	**56**	**48**	**13,8**	**12**	**44,4**	**38**	**13,5**	**12**	**31,2**	**27**
Transnistrian DR	**670**	**85.3**	**100**	**60**	**9,0**	**568**	**85**	**39,6**	**5.9**	**32,8**	**4.9**	**6,8**	**1**
Dnestrovsc	555	70.7	83	2,7	0.5	553	100	0	0	0	0	0	0
Tiraspol	22,1	2.8	3.3	18,6	84	3,5	16	0	0	0	0	0	0
Bender	21,6	2.8	3.2	19,9	92	1,7	7.9	0,04	0	0,04	0	0	0
Râbnița	13,4	1.7	2.0	10,7	80	2,9	22	0	0	0	0	0	0
Total RM	**785**	100		**116**	15	**582**	74	**84**	**11**	**46**	5.9	**37,9**	4.8

Source: Elaborated by the author according to data from the Annual Reports of the Water Agency of Moldova.

On average, 24.2 million m³ were used in the Northern DR, which represents 3.1% of the total volume of water abstracted in the Republic of Moldova and 21% in the right side of the Dniester River (Table 2). The maximum volume of water was used in the larger districts, namely in Edineț (2.4 million m³), Soroca (2.4 million m³ of water), Briceni and Florești (2.1 million m³ each). An average volume of water is also used in Drochia and Râșcani districts (1.9 million m³ each), which have more extensive functional aqueducts and higher water consumption. The minimum volume is recorded in smaller districts, including Dondușeni (928 thousand m³), Glodeni and Ocnița (1.2 million m³ each).

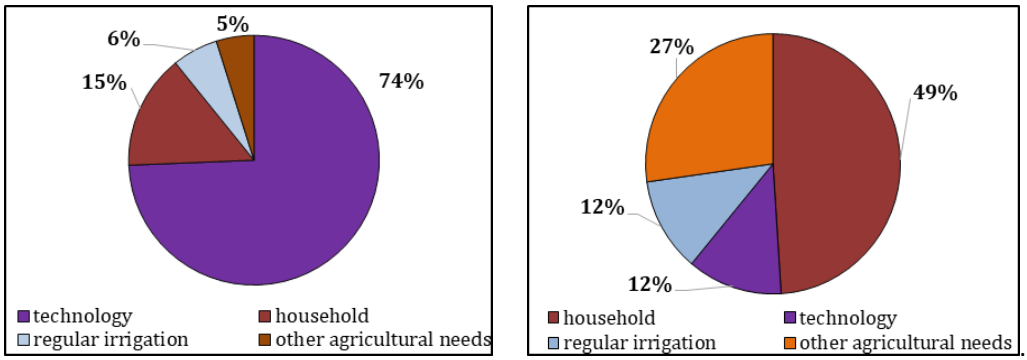
In the Central DR, an average of 25.1 million m³ or 3.2% of the total volume of water used in the Republic was used and 17% in the right side of the Dniester River. Maximum volumes of water were used in Anenii Noi (3.8 million m³), Orhei (3.4 million m³) and Ungheni (2.7 million m³) districts. An average volume of water is used in Ialoveni (2.3 million m³) and Criuleni (2.2 million m³) districts. The minimum volume of water used is also recorded in districts with smaller size, smaller urban and industrial centres and lower irrigation capacities, including in the Șoldănești (832 thousand m³), Nisporeni (1 million m³), Rezina and Călărași (1.1 million m³ each) districts.

In the Chișinău municipality an average of 50.2 million m³ was used, which represents only 6.4% of the total volume of water used in the Republic of Moldova and 43% of the water used on the right side of the Dniester River, and in the Bălți municipality - 5.1 million m³ (5%).

In the Southern Region an average of 16.2 million m³ of water was used, or 14% of the total volume of water used in the right side of the Dniester River (table 2), including in the districts of Southern DR - 13.6 million m³ (12%) and in ATU Găgăuzia - 2.6 million m³ (2%). The maximum volume of water used is recorded in the districts with direct access to the Dniester and Prut rivers, including Cahul (3.1 million m³), Ștefan Vodă (2.5 million m³) and Căușeni (2.4 million m³) and in ATU Găgăuzia with a higher

level of urbanisation and access to public aqueducts. The minimum volume was used in Basarabeasca (761 thousand m^3), Leova (1.1 million m^3) and Cantemir (1.2 million m^3) districts.

If we also take into consideration the official data available from the Transnistrian DR, then ≈¾ (582 million m^3) of the total volume of water used in the Republic of Moldova is used for technological (industrial) purposes. About 15% or 116 million m^3 is used for domestic purposes, and only 11% or 84 million m^3 is used in agriculture, of which 46.1 million m^3 (6%) for irrigation (Figure 5.a). In the Transnistrian DR, an average of 568 million m^3 or 85% of the total volume is used for technological purposes, 60 million m^3 (9%) for domestic purposes and 39.6 million m^3 (6%) for agricultural purposes, including 32.8 million m^3 (5%) for irrigation.



(a) **(b)**

Figure 5. Share of water use categories in the Republic of Moldova total (**a**) and without Transnistrian DR (**b**).
Source: Elaborated by the author according to data from the Annual Reports of the Water Agency of Moldova.

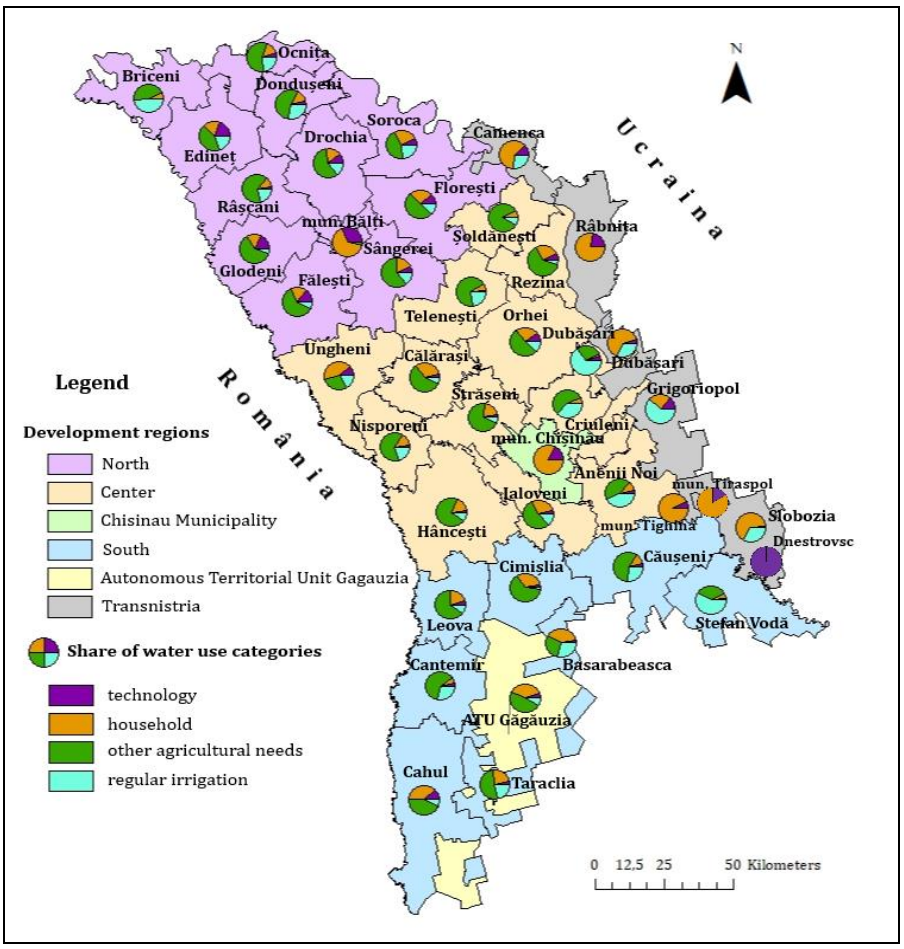


Figure 6. Share of water use categories in the Republic of Moldova, average of 2003 - 2022 years.
Source: Elaborated by the author according to data from the Annual Reports of the Water Agency of Moldova.

Excluding the Transnistrian DR, approximately ≈1/2 (56 million m^3) of the total volume of water was used for domestic purposes (Figure 5.b). This is conditioned by Chişinău, where 41 million m^3 of water or about 73% of the total volume of water used for domestic purposes in the right side of the Dniester River was used for domestic purposes. In agriculture, an average of 44.4 million m^3 of water or 38% of the total volume was used, including 13.5 million m^3 (12%) for irrigation and 13.8 million m^3 (12%) for industrial purposes. At the same time, in most of the districts on the right side of the Dniester River more than ¾ of the total volume was used for agricultural purposes.

In the Chişinău municipality (Figure 6), more than 80% was used for domestic purposes, 17% (8.5 million m^3) for technological purposes and only 1.1% (560 thousand m^3) of the total volume for agricultural purposes. In Bălţi, about 2/3 (3.4 million m^3) of water was used for domestic purposes, 31% (1.5 million m^3) for technological purposes and only 3% (163 thousand m^3) for agricultural purposes.

5.3.1. Water use for technological needs

Water consumption for technological (industrial) purposes is conditioned by the size and number of urban and industrial centres, water consumption in main industrial enterprises. Thus, of the 582 million m^3 of water used for industrial purposes, 98% is used by enterprises in the Transnistrian DR (table 2), including 553 million m^3 (80%) at the Dnestrovsc Thermoelectric Power Station only, which determines the detached predominance of technological uses in the Republic of Moldova, despite its agrarian character. In addition, according to the data of the Statistical Service of the Tiraspol authorities, in 2019, ≈300 million m^3 more was used for technological purposes than the amount reported by the Water Agency of Moldova. A high consumption of technological water is also observed in industrial enterprises in the cities of Tiraspol (3.5 million m^3), Râbniţa (3.0 million m^3) and Bender (1.7 million m^3), which have a higher level of industrialization and water consumption than the cities on the right bank of the Dniester. This is due to geostrategic planning during the Soviet period and the concentration of the most important heavy industry enterprises (electro-energy, steel, machine building) - in Transnistria.

On the right side of the Dniester River, the maximum volume of water used for technological purposes is recorded in Chişinău - 8.5 million m^3 or 62% of the total volume of industrial water used on the right side of the Dniester River. In the Northern DR, an average of 3.3 million m^3 (24%) was used for technological purposes, of which ≈ ½ - in the Bălţi municipality, which has a higher level of industrialization compared to the Central and Southern DR. An average level of water consumption for technological purposes is recorded in districts with medium-sized urban and industrial centers, including Edineţ (484 thousand m^3), Floreşti (244 thousand m^3) and Făleşti (211 thousand m^3) in the Northern DR, Orhei (339 thousand m^3) and Ungheni (319 thousand m^3) in the Central DR, Cahul (369 thousand m^3) in the Southern DR.

5.3.2. Water use for domestic purposes

In the period 2003-2022, an average of 116 million m^3 or about 15% of the total volume was used for domestic purposes. Domestic water consumption is conditioned by the size and number of urban centers and rural settlements with extensive metered water supplies and the number of population with access to public water supplies. In addition, in the generalised reports of the Water Agency of Moldova, water delivered to households by urban water supply companies is frequently attributed to domestic use, while the volume of water distributed by municipalities and other various categories of operators of public water supply systems in rural areas is frequently attributed to agricultural use. This considerably reduces (up to 20-30%) the share of domestic water use in the districts of the Republic. In the Transnistrian DR, an average of about 60 million m^3 was used for domestic purposes, which represents more than ½ (52%) of the volume of water used for these purposes in the Republic of Moldova and only 9% of the total volume of water used in the region. The maximum consumption for domestic purposes in this region is in the cities of Bender (19.9 million m^3), Tiraspol (18.6 million m^3) and Râbniţa (10.7 million m^3).

According to the data of the Water Agency of Moldova, an average of 56 million m^3 or 48% of the volume of water used for domestic purposes in the Republic of Moldova was used on the right side of the Dniester River. In Chişinău municipality, an average of 41.1 million m^3 of water was used for domestic purposes, which represents ≈3/4 of the total volume of domestic water used in the right side of the Dniester River and 82% of the total volume of water used in the capital, in the North DR - 6.7 million m^3

(12% and, correspondingly 27%), including in Bălți - 3.4 million m^3 (or 2/3 of the total volume), in Central DR - 4.8 million m^3 (8% and correspondingly 19%), in Southern DR - 2.8 million m^3 (5% and correspondingly 21%), and in ATU Găgăuzia - ≈930 thousand m^3 (2% and correspondingly 35%). Also, a large volume of water for domestic purposes was used in districts with larger urban centers, including Ungheni and Cahul (1.1 million m^3 each) and with higher distribution and consumption capacities of drinking water abstracted from the Prut River (Burduja & Bacal, 2022).

The highest share of water used for domestic purposes is found in the Chișinău (82%), Bălți (67%), Bender (92%) and Tiraspol (84%) municipalities. A high share (<30%) is found in the Ungheni and Cahul districts, with larger urban centres, as well as in the Călărași and Camenca districts, which have seaside resorts with high water consumption. In most of the districts (17 out of 32), the share of domestic uses is on average 15-30%, and the volume of water used for these purposes shows a marked upward trend. At the same time, if we add the volume of water distributed by rural public aqueducts usually allocated to agricultural uses, then the share of water used for domestic purposes in many districts will increase by up to 20-30%.

5.3.3. Water use for agricultural purposes

For agricultural purposes, an average of 84 million m^3 was used, which represents only 11% of the total volume of water used in the Republic, including 46.3 million m^3 (5.9%) - for irrigation. Despite a much lower share compared to industrial and domestic uses, agriculture predominates in the consumption of water resources in 4 out of the 6 development regions of the Republic, except for the Chișinău municipality and Transnistrian DR. The volume of water used in agriculture is conditioned by the availability of surface water resources, the density of the hydrographic network, the length and flow of watercourses, the level of water use in agriculture and the water use capacities of farmers. The maximum water consumption in agriculture is found in the districts, which have large capacities for distribution and use of water abstracted from the Dniester and Prut riverbeds, as well as from reservoirs used for irrigation. Also important is the presence of large agricultural households, which practice intensive technologies, including high water consumption and meeting current domestic and foreign market requirements.

In the Transnistrian DR, despite a much smaller share (12%) of the total surface area, an average of 39.6 million m^3 or 47% of the total volume of water used for agricultural purposes in the RM and only 6% of the total volume of water used in the region was used for agricultural purposes, due to the predominance of industrial uses. The maximum consumption of water in agriculture is observed in Grigoriopol (2.6 million m^3), Dubăsari (1.2 million m^3) and Slobozia (923 thousand m^3) districts, where the absolute majority of irrigated land and irrigation systems are concentrated, both those inherited from the Soviet period and those recently built by large agricultural companies.

On the right side of the Dniester River, an average of 44.8 thousand m^3 was used in agriculture, which represents 53% of the total volume of water used in agriculture in the Republic of Moldova (figure 5.b), including 18.8 thousand m^3 (42%) in the Central DR, 14.2 thousand m^3 (32%) in the Northern DR, 9.9 thousand m^3 (22%) in the Southern DR, 1.4 thousand m^3 (3%) in ATU Găgăuzia and 572 thousand m^3 (1.1%) - in the Chișinău municipality.

In the Northern DR, an average of 59% of the total volume of water used in the region was used for agriculture. The maximum consumption of water in agriculture is observed in Briceni (1.9 million m^3), Râșcani and Soroca (about 1.6 million m^3 each), Edineț (1.5 million m^3). The maximum share (≥80%) of agriculture is found in Briceni (91%), Râșcani (87%), Dondușeni (82%) and Ocnița (81%) districts, where large agricultural enterprises operate, and consumption for domestic purposes is lower, due to the population's lesser access to public aqueducts. In Drochia and Sângerei districts, ¾ of the total volume of water used for agriculture is used, while in the remaining districts it constitutes 60-70% due to the higher consumption of water for domestic and industrial purposes in the urban localities of these districts.

In the Central DR, an average of 18.8 million m^3 of water, or about ¾ of the total volume of water in the region, which has a pronounced agricultural and rural character, was used for agricultural purposes. The maximum volume of water used for agricultural purposes is recorded in Anenii Noi (3.0 million m3), Orhei (2.2 million m^3), Criuleni (2.1 million m^3) and Dubasari (1.9 million m^3) districts. An

average water consumption in agriculture is observed in the districts bordering the Prut River with larger areas - Hincesti (1.5 million m^3) and Ungheni (1.2 million m^3), as well as in Ialoveni district (1.5 million m^3). Minimum consumption is observed in smaller districts, such as Rezina (745 thousand m^3), Şoldăneşti (765 thousand m^3) and Nisporeni (840 thousand m^3). The maximum share (≥90%) of agriculture is found in Criuleni, Dubasari, Teleneşti districts. In the districts of Hincesti and Nisporeni more than 80% of the total volume of water used is allocated to agriculture.

In the Southern DR, on average about 10 million m^3 of water or ≈¾ of the total volume of water in the region, which has the most pronounced agrarian and rural character, was used for agricultural purposes. Therefore, the maximum volume of water used for agricultural purposes is recorded in the districts bordering the Dniester River: Ştefan Vodă (2.3 million m^3) and Căuşeni (2.0 million m^3), as well as in the large Cahul district (1.6 million m^3) located near the Galaţi city, where a large part of the agricultural production is delivered. Minimum water consumption in agriculture is found in Basarabeasca (445 thousand m^3), Cimişlia (701 thousand m^3) and Leova (781 thousand m^3). The maximum share (≥80%) of agriculture is in the districts of Ştefan Vodă, Căuşeni and Cantemir, and the minimum share in the districts of Cahul (52%) and Basarabeasca (67%) and is due to the higher consumption of water for domestic and industrial purposes in their urban centres. In ATU Găgăuzia, an average of 1.4 million m^3 or only 3% of the total volume of water used for agricultural purposes in right side of the Dniester River and 53% of the total volume of water used in the region was used for agricultural purposes. The lower share of agriculture is explained by higher consumption for domestic purposes, due to higher access to public aqueducts. The highest water consumption is registered in the large agricultural enterprises with a complex profile in the region, in the Association of Irrigation Water Users of Vulcăneşti and in the vineyards.

On average 46.3 million m^3 or ≈6% of the total volume of water used was used for regular irrigation, including 32.8 million m^3 in the Transnistrian DR and 13.5 million m^3 in the right side of the Dniester River (figure 5.a), of which 5.8 million m^3 (41%) in the Central DR, 3.9 million m^3 (30%) in the Northern DR, 3.3 million m^3 (25%) in the Southern DR, 221 thousand m^3 (1.6%) in ATU Găgăuzia and 241 thousand m3 (1.6%) in Chişinău municipality.

The maximum share of water used for irrigation in the total volume is recorded in the riverside districts on both sides of the Dniester on the sectors between the Dubasari Reservoir and the mouth of the Dniester River, including Grigoriopol and Ştefan Vodă districts (60% each), Dubasari (63% on the right side and 33% on the left side of the Dniester), Anenii Noi (40%) and Criuleni (33%). The maximum share of water used for irrigation is also attested in Briceni (≈50%) and Ungheni districts, where the largest capacities for pumping and distributing water from the Prut River for irrigation were concentrated. In most of the northern districts there is an average share (15-30%) of water used for irrigation, which is due to the more pronounced agrarian character in the Northern DR. In addition, in recent years, there has been a frequent demand from efficient agricultural enterprises for water from the Dniester and Prut rivers in order to meet the growing demands of the external market in CIS countries and the Middle East. In most of the central and southern districts, especially in the western part, a low share of water used for irrigation is observed, due both to the relatively large distance from Dniester River and the unsatisfactory condition of most reservoirs (Burduja & Bacal, 2022).

In the Transnistrian DR, an average of 32.8 million m^3 or only ≈5% of the total volume of water used in the region was used for irrigation. The maximum volume of water used for irrigation is recorded in the districts located downstream of the Dubăsari Reservoir, including Grigoriopol (2.6 million m^3), Dubăsari (1.2 million m^3) and Slobozia (920 thousand m^3). Unlike on the right side of the Dniester River, most of the water abstraction and pumping stations for irrigation have been preserved and subject to much stricter monitoring, and with affordable investments can be rehabilitated.

On the right side of the Dniester River, an average of 13.5 million m^3 or only 12% of the total volume of water used for irrigation was used. The small volume of water used for irrigation is conditioned by natural conditions and the possibilities of using water for irrigation.

In the Northern RD, an average of 3.9 million m^3 of water, or 16% of the total volume of water used in the region, was used for irrigation. The maximum water consumption for irrigation purposes, according to the Inspectorate for Environmental Protection, is recorded at: Technological Irrigation

Stations and Associations of Water Users for Irrigation in Briceni, Drochia (220 thousand m³), Edineţ (166 thousand m³) districts, agricultural enterprises practicing intensive agricultural techniques and oriented to internal and external commercial networks, including "Climăuţeanu Agro" (500 thousand m³)and Agropanfil (162 thousand m³) enterprises, SA "Alfa-Nistru" (513 thousand m³) from Soroca district, SRL „Dimazcom Nord" (112 thousand m³) and from Drochia district, SRL„Vardan Agro" (137 thousand m³) and SRL„Vapricom" (63 thousand m³) from Râşcani district; Vladisvaleo Ltd. (155 thousand m³), "Danulschii" Company (42.4 thousand m³) from Glodeni district.

In the Central RD, an average of 5.8 million m³ or 23% of the total volume of water used was used for irrigation. A maximum volume was used at: Technological Irrigation Stations and Associations of Water Users for Irrigation in Anenii Noi (830 thousand m³), Dubasari (580 thousand m³), Criuleni (530 thousand m³), Ungheni (410 thousand m³) districts; large and medium agricultural enterprises SRL Lobi Logistic (62 thousand m³), in Teleneşti district; SRL "Octama" (363 thousand m³), SRL„Gorobica-Agro" (67,1 thousand m³) and SRL "Işcomagro" (55,6 thousand m³) from Criuleni rayon, IS „Serele Moldovei" (236 thousand m³) and CAP Basarabia (75, 4 thousand m³) from Anenii Noi district, GŢ Urîtu Semion (29,7 thousand m³) from Dubăsari district, SA "Minjir Agro" (83 thousand m³), SRL "Vitis-Vinifera" (61,2 thousand m³) from Hânceşti district.

In the Southern DR, an average of 3.4 million m³ of water or 25% of the total volume of water used in the region was used for irrigation. The maximum consumption of water for irrigation purposes is recorded at: the Technological Irrigation Stations in Ştefan Vodă district (1.1 mil. m³) and Vulcanesti (352 thousand m³); Associations of Water Users for Irrigation in Căuşeni, Cahul and Leova districts; large agricultural enterprises with a complex profile SA„Nistru-Olăneşti" (234 thousand m³) from the district of Ştefan Vodă, SRL Baimaclia agro (106 thousand m³) and SRL Hagimus agro (37,5 thousand m³) from the district of Căuşeni, CAP "Ciobalaccia" (218 thousand m³) and CAP "Glia" (134 thousand m³) from the district of Cantemir, SRL Sadac-Agro (264 thousand m³) from the district of Basarabeasca.

5.3.4. Dynamics of the volume of water used

In the years 2003-2022, similar to the abstracted water, the total volume of water used shows an oscillating evolution against a general negative trend (Figure 7). In the years 2003-2006, on the right side of the Dniester River a reduction is observed, which is more pronounced in the volume of water used for domestic purposes in the Chişinău municipality and for agricultural uses - in the Southern Region, due to the decommissioning of state irrigation systems, bankruptcy and reduction of industrial production, etc. In the years 2008-2014, there is a general negative trend, which is manifested in all categories of water use and in all regions.

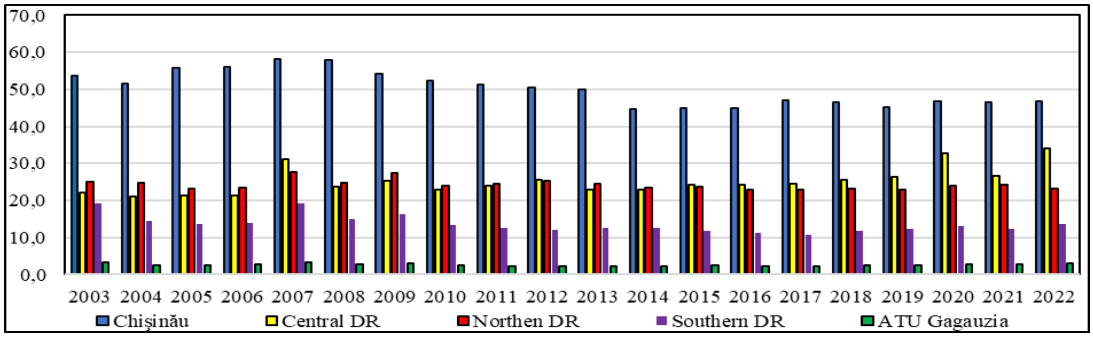


Figure 7. Dynamics of water use in the Republic of Moldova by development regions, in million m³.
Source: Elaborated by the author according to data from the Annual Reports of the Water Agency of Moldova.

In the years 2015-2022, the volume of water used shows a positive dynamic, with the maximum growth rates in the Central DR (Figure 7), due to the partial restoration of irrigation systems in the riparian districts, especially through the Compact Program, and the massive consumption of water in irrigation in 2020 and 2022 which were quite dry. In 2022, due to drought and lack of rainfall, the total volume of water used in Moldova was 789 million m³, or about 9 million m³ more than in 2021. On the right side of the Dniester River 120 million m³ were used, of which 46.7 million m³ (39%) - in Chişinău

municipality, 34 million m³ (28%) - in the Central DR, 23.3 million m³ (20%) - in the Northern DR, 13.5 million m³ (11%) - in the Southern DR and 2.9 million m³ (2%) - in ATU Găgăuzia.

In the Northern DR, during the period 2003-2022, there is also an oscillating evolution, and the total volume of water used in 2022 is 1.8 million m³ less than in 2003. The reduction of the total volume of water used is observed in the Bălți municipality (by 11%) and in 6 of the 11 districts of the region, being caused by the decrease of industrial water uses. The increase of the total volume of water used is recorded in Soroca (1.6 times), Florești (+27%), Drochia (+17%) districts, where there is a faster expansion of rural public aqueducts and a more active revival of agro-industrial enterprises.

In the Central DR, the maximum reduction in the total volume of water used in 2008-2014 is recorded in Dubasari (3.0 times), Anenii Noi (1.9 times), Hincesti (1.8 times), Nisporeni (1.7 times). At the same time, water consumption increased in Strășeni (+25%), Telenești (+11%) and Călărași (+9%) districts, due to the increase in water abstraction capacities of large agricultural enterprises near Chișinău and Bălți. In the Central DR, in the years 2015-2022 (except 2021), there is a significant increase (by 35%) in the volume of water used, due to increased demand and massive consumption of water in irrigation in 2020 and 2022. The positive dynamics is recorded in all districts of the region, except in the district of Șoldănești. The maximum increase is recorded in Dubasari (2.1 times), Nisporeni (1.9 times), Criuleni (1.8 times) and Anenii Noi (1.6 times) districts. In 2022, 7.3 million tons of water were used in the districts. m3 more water was used in 2022 than in 2021, and it is almost exclusively due to the increase in the volume of water used for irrigation, as a result of the very low amount of precipitation in 2022, with the most significant increase in the districts bordering the Dniester River such as Criuleni (+2.6 mil. m³), Anenii Noi (+2.1 mil. m³) and Dubăsari (1.5 mil. m³).

In the Southern Region (Southern DR and ATU Găgăuzia) there is a maximum reduction (by 30%) in the total volume of water used, caused by the massive deterioration and decommissioning of centralized irrigation systems, the significant decrease in production volumes and the bankruptcy of many agricultural and agro-industrial enterprises, the application of the Russian embargo (since 2006) on Moldovan agricultural products. Negative dynamics are observed in all districts except Cimișlia. The biggest decrease in the volume of water used, by about 50%, is observed in the Basarabeasca, Taraclia and Cantemir districts (by about 50%). Also, a reduction of more than 60% in the volume of water used is recorded in the district of Căușeni (by 2015), which is due to the gradual disconnection of the pumping station in Bender, the massive deterioration of the other pumping stations in the area (Leuntea, Chircaiești, Căușeni) and the hydrotechnical installations for water distribution for irrigation.

In the Southern DR and ATU Găgăuzia, the total volume of water used in 2015-2022 increased by 17%, and the positive dynamics is recorded in 5 out of 8 districts of the Southern DR, including ATU Găgăuzia. The maximum increase is observed in Leova (+80%), Taraclia (+39%) and Căușeni (+36%) districts. In 2022, 1.3 million m³ of water were used more than in 2021, which is due to the increase in the volume of water used in the Southern DR, especially for irrigation, due to insufficient rainfall this year.

The maximum volume of water used for technological purposes was reached at the end of the 1980s (about 2.5 billion m3) and decreased by 2002 to about 600 million m³. If we take into account the data of the AAM concerning the Transnistrian DR as well, then in the period 2003-2014 the volume of water used for these purposes is almost constant. At the same time, in the right side of the Dniester River, in the period 2003-2016 there is a constant negative dynamic.

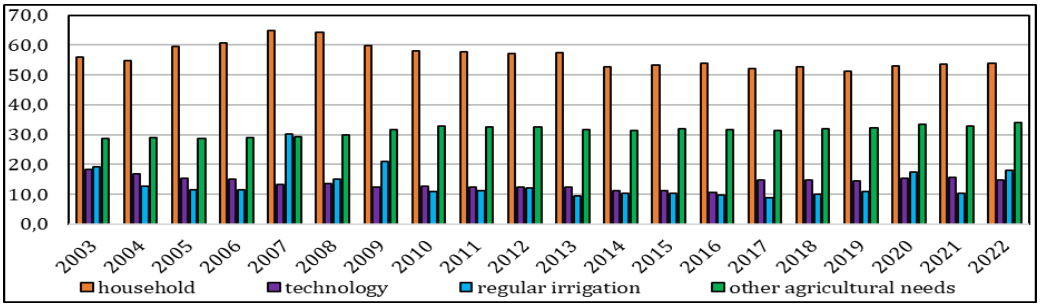


Figure 8. Dynamics of water use by use category, in million m³.

Source: Elaborated by the author according to data from the Annual Reports of the Water Agency of Moldova.

Overall, the total volume of water used for technological purposes on the right side of the Dniester River has decreased by about 20% or from 18.4 million m^3 to 14.8 million m^3. This dynamic is to a large extent due to the significant reduction of industrial water uses in the Northern DR (2.6 times), especially in the Bălți municipality (4 times). The significant reduction of water volume is registered in the districts where several industrial enterprises have stopped or significantly reduced their production activity, especially sugar factories, wine factories, meat processing enterprises, dairy factories, etc. The negative trend is also due to the modernisation of many enterprises, especially wine factories, meat and milk processing centers.

In recent years (2016-2022), there has been a significant increase (≈1.3 times from 10.5 million m^3 to 14.8 million m^3) in the volume of water for technological uses on the right side of the Dniester River. This dynamic is mainly due to the increase in the volume of water for industry in the municipality. The positive trend is not only due to the increase in the volume of industrial production, as a result of the implementation of the Association Agreement with the EU, but also to the increase in the level of statistical recording and reporting of water consumption.

According to the data of the Water Agency of Moldova, the total volume of water used for *domestic purposes* has a weakly oscillating evolution, conditioned both by almost constant data from the Transnistrian DR (with the exception of the city of Râbnița), as well as by the quantity and regime of atmospheric precipitation, the evolution of the socio-economic situation. At the same time, on the right side of the Dniester River, there is a general negative development. At the beginning of the period analysed (2003-2007), there was a significant increase of 16% in the volume of water used for domestic purposes (Figure 8), including 19% (8.1 million m^3) in the Chișinău municipality and 15% (610 thousand m^3) in the Central DR.

In the years 2008-2019, there is a sharp downward trend (1.4 times or from 64.8 million m^3 to 51.4 million m^3), caused by the decrease in the volume of domestic water in the Chișinău municipality (from 50.5 million m^3 to 34.5 million m^3). In the years 2020-2022, the positive dynamics is recorded throughout the country, especially in the small districts. The positive dynamics are due to the expansion of public water supply systems and the increase in metered water consumption.

According to data from the Water Agency of Moldova, the volume of *water used in agriculture* shows a fluctuating but generally negative trend, which was more intense in 2003-2006 and 2010-2013.
In 2003-2006, the volume of water used for agriculture in the right side of the Dniester River decreased on average by 1.3 times (by 7.5 million m^3), with the maximum reduction in the Southern DR (by 1.7 times) and in ATU Găgăuzia (by 1.4 times). At the same time, the positive dynamics are recorded in most of the central districts (7 out of 13), in Soroca and Fălești districts of the Northern DR, and the maximum increase is recorded in Dubasari (+30%), Călărași and Nisporeni (+20%). In the period 2008-2017 there is a significant reduction (more than 1.6 times) in the volume of water used in agriculture, interrupted in 2009. The highest rates of reduction are observed in the Southern DR (by 2.2 or from 15.5 million m^3 to 7.2 million m^3) and in ATU Găgăuzia (by 1.8 times or from 2.0 million m^3 to 1.2 million m^3). In the years 2017-2022, the positive dynamics are recorded in all development regions on the right side of the Dniester River, including in the Central DR - 1.5 times and in the Southern DR - 1.3 times.

In 2022, the total volume of water used in the Republic of Moldova was 788 million m^3 or about 8 million m^3 more than in 2021, which is due to the precipitation deficit and increased water consumption, especially for irrigation. On the right side of the Dniester River, 120 million m^3 were used, of which 46.7 million m^3 (39%) - in the Chișinău municipality, 34 million m^3 (28%) - in the Central DR, 23.3 million m^3 (20%) - in the Northern DR, 13.5 million m^3 (11%) - in the Southern DR and 2.9 million m^3 (2%) - in ATU Găgăuzia. As a result of the significant reduction in the volume of water used in the Chișinău municipality, the share of the respective regions is lower compared to the average for the period under analysis, and the share of the Central DR is higher.

5.4. Public water supply systems

The number and length of public aqueducts are conditioned by the size of the districts and municipalities, the number and size of the component localities, which have extensive functional aqueducts, the available water reserves and the technical and financial capacities for their exploitation, as well as the territorial organization of the public water supply services. Thus, in 2021, 1,365 public water

supply systems were registered, including 633 (46%) - in the Central DR, 335 (25%) - in the Southern and Northern DR, 41 (3.0%) - in the ATU Găgăuzia and 21 (1.5%) - in Chişinău municipality.

The maximum number of public water supply systems is recorded in Orhei (98), Teleneşti (87), Anenii Noi (78) districts in Central DR; Cimişlia (68), Cahul (65), Căuşeni (63) in Southern DR. The minimum number is observed in Chişinău municipality (21), as well as in small peripheral districts such as Dubasari (11), Leova and Basarabeasca (16 each), Taraclia (17) and Nisporeni (19). The rural environment is by far predominant, with 95% of the total number (Burduja & Bacal, 2022) .

The total length of public aqueducts was 16.4 thousand km, including in the Central DR - 5.8 thousand km, in the Northern DR - 4.1 thousand km, in the Southern DR - 3.6 thousand km, 2.0 thousand km - in mun. Chişinău and 970 km - in ATU Găgăuzia. The maximum length of public aqueducts is recorded in the districts of Orhei (842 km), Hânceşti (662 km), Anenii Noi (593 km) in the Central DR; Floreşti (564 km) and Sângerei (507 km) in the Northern DR; Căuşeni (714 km) and Cahul (706 km) in the Southern DR. The minimum length is in Bălţi municipality (273 km), as well as in districts with a small number of localities connected to public aqueducts, including Ocniţa (67.7 km), Donduşeni (156 km), Şoldăneşti (169 km), Dubăsari (203 km), Briceni (214 km), Basarabeasca (216 km).

As a result of the rapid expansion of the public water supply network, currently about 2.3 million people or 2/3 (69%) of the total population in the Republic of Moldova (excluding the Transnistrian DR) have access to public water supply systems, including 1.3 million people or 93% - from urban areas and 990 thousand people or 52% - from rural areas.

In the Northern DR have access to public water supply systems 454 thousand people or 51% of the population present, of which 83% in urban areas and only 34% in rural areas. The Northern DR has the lowest level of access to public water supplies, especially in rural areas. The highest access is in Bălţi municipality (84%), Râşcani (74%) and Sângerei (60%) districts, and the minimum in Ocniţa (17%), Briceni (25%) and Donduşeni (32%) districts. In urban areas, the number of people connected to public aqueducts is directly proportional to the size of the population. Thus, the maximum number of people connected to the aqueduct is recorded in Bălţi (104 thousand), Soroca (31.8 thousand) and Făleşti (15.7 thousand). The cities of Bălţi, Floreşti, Făleşti, Râşcani, Sângerei have the highest access to public aqueducts, and the lowest access - Ocniţa (47%) and Donduşeni (52%). In rural areas, the highest level of access is in Râşcani (66%) and Sângerei (53%), and the lowest in Ocniţa (0%), Briceni (15%), Soroca (22%) and Donduşeni (27%), the lowest in the whole country.

In the Central DR there are 579 thousand people or 60% of the population present in the public aqueducts, including 159 thousand (90%) in urban areas and 420 thousand (52%) - in rural areas. The maximum access of the population to public aqueducts is in Ialoveni (83%), Anenii Noi (78%) and Orhei (70%) districts, and the minimum access - in Şoldăneşti (29%) and Străşeni (38%) districts. Full access to public aqueducts is observed in the cities of Orhei, Călăraşi, Ialoveni, Criuleni, and minimum access - in the cities of Teleneşti (50%) and Străşeni (71%). In rural areas the highest degree of access is observed in the districts of Ialoveni (79%) and Anenii Noi (76%), and minimum access - in the districts of Şoldăneşti (18%), Străşeni (27%) and Hancesti (40%).

In the Chişinău municipality, 766 thousand people or 97% of the total population are connected to the public aqueducts, including ≈100% in urban areas and 78% in rural areas.

About 70% (350 thousand people) of the population of the Southern DR has access to public water supply systems, including 88% (113 thousand) - in urban areas and 66% - in rural areas. The highest access is in Basarabeasca (95%), Căuşeni (87%), Ştefan Vodă (82%) and Cimişlia (81%), and the lowest - in Leova (26%) and Cantemir (53%). In rural areas, the highest degree of access is recorded in Basarabeasca (92%), Căuşeni (86%), Ştefan Vodă (81%) and Cimişlia (72%) districts, and the minimum access - in Leova (26%), Cantemir (50%) and Taraclia (58%) districts. In ATU Găgăuzia, the degree of access of the population to public aqueducts is quite high, being connected 123 thousand people or 82% of the total population (Burduja & Bacal, 2022).

5.5. SWOT analysis of water resources use in the Republic of Moldova

Although the SWOT analysis of water resources use in the Republic of Moldova identified several weaknesses and risks, there are a number of strengths and opportunities for the development and management of this area, which are listed in Table 3.

Table 3. SWOT analysis of water resources use in the Republic of Moldova.

Strengths	Weaknesses
- Sufficient water resources; - Presence of main aqueducts (Vadul lui Voda-Chișinău, Soroca-Bălți-Sângerei, Prut-Fălești, Prut-Edineț); - Good practices in the development of irrigation systems by UAI supported by the Compact Programme, especially in the riparian districts downstream of the Dubasari reservoir; - Significant increase in access to public aqueducts, particularly in rural localities in Central and Southern DR; - The majority of pumping stations of water supply companies are operational; - Water supply to the population is a main thrust of regional and local strategies and programmes and a priority of the Regional Development Agencies; - The presence of wells and springs with a high water flow is a valuable source of water, especially for the rural population.	- Insufficient technical and economic capacity to exploit surface water resources; - Advanced state of wear of previously built irrigation systems and slow expansion of new centralised irrigation systems; - Significant increase in maintenance costs of irrigation systems; - Reduced access to public aqueducts in rural localities in Northern DR and some central districts; - Underfunding of the SWA sector, in particular the sources of co-financing of SWA projects; - A good part of the pumping stations of irrigation systems and agricultural and industrial enterprises built during the Soviet period are out of use, being damaged or massively worn out; - The large number of unused wells and their advanced wear and tear; - High level of water pollution of wells and springs.
Opportunities	**Threats**
- Increase the number of water pumping stations and ensure the proper functioning of existing ones; - Siting new boreholes according to water requirements; - Implementation of measures for the development of public water supply systems stipulated in the Regional Development Strategies and the Regional Sectoral Programme in this field; - Extension of the water supply network in the rural area of the region by attracting foreign investments in the context of accession to the European Union; - The liquidation or conservation of exploited wells will contribute significantly to water protection; - Adequate implementation of Regional Water Supply and Sanitation Programmes; - Optimised systems for reporting, monitoring and evaluation of water resources use performance.	- Accelerating climate change; - Significant population decline, accelerated ageing, particularly in rural areas; - Unused artesian wells are frequently not conserved and cause groundwater pollution; - Acute shortage of financial resources to implement planned measures and actions; - Increased negative socio-economic effects resulting from the operation of hydropower complexes on the Dniester and Prut rivers; - Major dependence on external sources of funding for projects in the field of water resources development and protection; - Reluctance of Local Public Authorities to regionalize water supply and sanitation services.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

The main water resources are located in the Dniester hydrographic basin district, where the river network is much denser. The most significant surface water resources are available in the districts

bordering the Dniester and Prut rivers, and underground - in the districts of the central part of the country bordering the Dniester river. The groundwater of the Badenian-Sarmatian aquifer complex is used most intensively, due to its distribution throughout the whole territory of the Republic and the better quality of the water, as well as the more available waters of the Alluvial-Deluvial aquifer.

Due to the limited access to public aqueducts, non-centralised sources (lakes, wells and springs) play an important role in water supply, especially in rural areas. Although the water in most wells and springs does not meet quality requirements, it is widely used for drinking purposes, which directly affects the health and quality of life of the population.

The volume of water abstracted and used is determined by the available water resources and the demand for water, as well as the capacities for water abstraction, transport and use. More than 80% (689 million m^3) of the total volume of water abstracted in the Republic comes from sources in the Transnistrian DR. On the right side of the Dniester River about ½ (79 million m^3) of the water is abstracted in the municipality of Transnistria. Chișinău, 21% - in the Northern DR, 17% - in the Central DR and 12% - in the Southern Region. About 85% of the abstracted water comes from surface sources, of which 553 million m^3 (65%) are abstracted from the Dniester riverbed and used at the Dnestrovsc Thermo-Electric Power Station, and only 20% (144 million m^3) - from the Dniester riverbed. Surface sources are predominantly used to supply water to urban and industrial centres, as well as large agricultural enterprises for irrigation. The majority of localities are supplied mainly from underground sources. The maximum share of surface sources is found in the cities of Dnestrovsc, Chișinău, as well as in the districts of Soroca, Edineț, Ungheni, Cahul, Dubasari and Ștefan Vodă, with extensive systems of water abstraction and distribution from the Dniester and Prut rivers.

If we also take into consideration official data from the Transnistrian DR, then ≈¾ (582 million m^3) of the total volume of water used in the Republic of Moldova is for technological purposes. About 15% or 116 million m^3 is used for domestic purposes, and only 11% or ≈84 million m^3 is used for agriculture, of which 46 million m^3 (6%) for irrigation. On the right side of the Dniester River, domestic uses prevail in the municipalities of Chișinău (82%) and Bălți (66%), and in the districts - agricultural uses.

The use of water for other agricultural needs is predominant in most districts, except for Dubasari, Anenii Noi, Ștefan Vodă and Briceni, where water use for irrigation is predominant, and Ungheni, Cahul and Basarabeasca, where domestic uses are predominant. The high share of non-irrigated agriculture is conditioned both by the pronounced agrarian and rural specificity of the districts and by the frequent allocation by the Water Agency of Moldova of water delivered by public rural water supply systems to agricultural use.

In the years 2003-2022, the total volume of water abstracted and used shows an oscillating evolution, based on a general negative trend, which is more pronounced for water abstracted from surface sources and used for domestic purposes in Chișinău municipality and for agricultural purposes - in the South Region. In the years 2007 and 2020, 2022, as a result of strong droughts, there is a maximum consumption of water. In the years 2015-2022, there is a positive dynamic, which is due to the restoration of some irrigation systems, but also to the increase in metered water consumption due to the significant expansion of rural public aqueducts.

Currently about 2.2 million people or ≈70% of the present population (excluding the Transnistrian DR) has access to centralized water supply systems, including 94% - urban and 53% - rural. At the same time, there is still limited access to public aqueducts in rural localities in the Northern and Central DR.

6.2. Recommendations

Considering the availability and quality of water resources, it is recommended to expand the capacities of water abstraction, treatment and distribution of water from the Dniester and Prut Rivers and allocated for domestic and agricultural uses, including irrigation of fields near the house. In this context, it is imperative to declare the main aqueducts as national security objectives and to apply rigorous control over their condition and operation.

As a result of the high proportion of non-operated boreholes, it is necessary to create a regulation on the location of new boreholes, based on environmental, social and technical-economic criteria, and to

conserve the non-operated ones correctly. In order to minimise the negative impact on the health of the population, permanent sanitary and ecological monitoring of wells, springs and lakes is essential. An important aspect in the efficient management of water resources is the extension of public water supply systems, especially in rural localities in the Northern and Central DR, to ensure planned access of the population to quality water, but also to monitor the consumption of water resources.

It is necessary to create and properly manage an Integrated Water Resources Information System to eliminate inconsistencies between different sources and databases. To this end, it is imperative that the public authorities responsible for water resources management in Chişinău (Republic of Moldova) and Tiraspol (Transnistrian DR) should create common platforms for reporting water use data, coordination and implementation of measures in the field of sustainable water resources development and management.

ACKNOWLEDGEMENTS

This article is a brief presentation of the monographic study "Assessment of water resources use and management in the Republic of Moldova. Case study: Northern DR" (Burduja & Bacal, 2022), developed in the framework of the Research Project 20.80009.7007.11 "Assessment of urban and rural ecosystem stability to ensure sustainable development" 2020-2023), as well as in the framework of the Doctoral Project " Economic and geographical aspects of water resources valorization and management in the Republic of Moldova", carried out in the Doctoral School of ASEM (2016-2022).

USE OF AI TOOLS DECLARATION

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

AUTHOR CONTRIBUTIONS

All authors contributed equally to this work. All authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Aznar-Sánchez, J. A., Belmonte-Ureña, L. J., Velasco-Muñoz, J. F., & Manzano-Agugliaro, F. (2018). Economic Analysis of Sustainable Water use: A Review of Worldwide Research. *Journal of Cleaner Production*, *198*, 1120–1132. https://doi.org/10.1016/j.jclepro.2018.07.066

Bacal, P. (2010). *Gestiunea protecţiei mediului înconjurător în Republica Moldova (Aspecte teoretice şi aplicative)*. Chişinău: ASEM. 240 p. (in Romanian)

Bacal, P., & Burduja, D. (2018). The regional pecularities of water use in the Republic of Moldova. *Lucrările Seminarului Geografic "Dimitrie Cantemir," 46*(2), 19–37. https://doi.org/10.15551/lsgdc.v46i2.02

Bacal, P., & Burduja, D. (2022). The peculiarities of the use of water resources in the Dniester Hydrographical District (sector of the Republic of Moldova). *Present Environment and Sustainable Development*, *2*(2), 159–171. https://doi.org/10.47743/pesd2022162012

Bacal, P., Burduja, D., & Ciocan, N. (2019). The peculiarities of water use in the Răut river basin. *Central European Journal of Geography and Sustainable Development*, *1*(1), 13–24. https://cejgsd.org/Article_002_CEJGSD.pdf

Bacal, P., Jeleapov, A., & Burduja, D. (2022). Status and use of water supply and sewerage systems in the Northern Development Region of the Republic of Moldova. *Central European Journal of Geography and Sustainable Development*, *4*(1), 23–41. https://doi.org/10.47246/cejgsd.2022.4.1.2

Băloiu, V. (1971). *Water Management*. Didactic and Pedagogical Publishing Press. (in Romanian)

Bejan, I., Bacal, P., Boboc, N., Angheluţa, V., Ţîţu, P., Stratan, L., & Iurciuc, B. (2020). *Management plan of the Botna hydrographic basin. Cycle I* (2021-2027). Chişinău, 91 p. http://mem.md/wp-content/uploads/2020/01/Plan-Management-Botna-14.12.2020.pdf (in Romanian)

Bejan, I., Bacal, P., Nedealcov, M., Jeleapov, A., Jeleapov, V., & Zgîrcu, N. (2019). *The Camenca river basin management plan. Cycle II (2019-2024)*. *Executive summary*. Chişinău, 28 p.

Bejan, I., Boboc, N., Bacal, P., Melniciuc, O., Nedealcov, M., Jeleapov, A., Angheluța, D., & Zgîrcu, N. (2016). *Management Plan of the Prut Hydrographic Basin. Cycle I, 2017-2022*. Chişinău. 116 p. (in Romanian)

Bejan, I., Nedealcov, M., Boboc, N., Bacal, P., Melniciuc, O., Jeleapov, A., Angheluta, V., Zgîrcu, N., Iurciuc, B., Melian, R., Bejenaru, G., Stratan, L., & Tabacaru, A. (2017). Management Plan of Danube - Prut and Black Sea River Basin District. Cycle I, 2017-2022. apelemoldovei.gov.md/public/files/Plan_Prut-Dunarea_01_11.2016._3.pdf. (in Romanian)

Bejenaru, Gh., & Melniciuc, O. (2020) *Water resources of the Republic of Moldova (formation theory and regional syntheses)*. Chişinău. 338 p. (in Romanian)

Boboc, N., & Bejan, I. (2019). Surface water resources of the Danube-Prut and Black Sea hydrographic district. *In: Current Status of Environmental Components*. https://doi.org/10.53380/9789975315593.05 (in Romanian)

Burduja, D., & Bacal, P. (2022). *Assessment of the use and management of water resources of the Republic of Moldova. Case study: Northern DR*. Institute of Ecology and Geography de Ecologie şi Geografie, Chişinău: Impressum SRL. 200 p. (in Romanian)

Burduja, D., Bacal, P., & Railean, V. (2020). The particularities of water use in the Central Region of the Republic of Moldova. *Present Environment and Sustainable Development*, *14*(1). https://doi.org/10.15551/pesd2020141001

Cazac, V., Mihăilescu, C., Bejenaru, G., & Gâlcă, G. (2010). *Aquatic resources of the Republic of Moldova*. Ştiinţa. 248 p. (in Romanian)

Cominola, A., Preiss, L., Thyer, M., Maier, H. R., Prevos, P., Stewart, R. A., & Castelletti, A. (2023). The determinants of Household Water Consumption: A review and Assessment Framework for Research and Practice. *npj Clean Water*, *6*(1). https://doi.org/10.1038/s41545-022-00208-8

Governmental Decision of the Republic of Moldova no. 814 of 17.10.2017 regarding the approval of the Management Plan of the Dniester River basin district. In: Official Monitor no. 371-382 from 27.10.2017. Retrieved from: https://www.legis.md/cautare/getResults?doc_id=102659&lang=ro. (in Romanian)

Giurma, I. (2000). *Water management systems*. Cermi. (in Romanian)

Grespan, A., Garcia, J., Brikalski, M. P., Henning, E., & Kalbusch, A. (2022). Assessment of water consumption in households using statistical analysis and regression trees. *Sustainable Cities and Society*, *87*, 104186. https://doi.org/10.1016/j.scs.2022.104186

Hâncu, C., & Niţescu, C. (2016). *Hydrotechnical installations*. Ovidius University Press. (in Romanian)

Inspectorate for Environmental Protection. *Yearbooks (2018-2021) on the quality of environmental factors and the activity of Ecological Inspections*. Preprint (in Romanian)

Iurciuc, B. (2017). *Groundwater.* Report. Agency for Geology and Mineral Resources. https://dniester-commission.com/wp-content/uploads/2018/07/geology_Moldova_Iurciuc.pdf (in Romanian)

Jeleapov, A., & Burduja, D. (2020). Water resources of rivers in the Northern Development Region. In: *Current challenges and trends in research on the natural and socio-economic components of urban and rural ecosystems.* https://doi.org/10.53380/9789975891608.12 (in Romanian)

Jorgensen, B., Graymore, M., & O'Toole, K. (2009). Household water use behavior: An integrated model. *Journal of Environmental Management*, *91*(1), 227–236. https://doi.org/10.1016/j.jenvman.2009.08.009

Law of the Republic of Moldova no. 438 of 28.12.2006 on regional development. In: Official Monitor no. 21-24 from 16.02.2007. https://www.legis.md/ (in Romanian)

Madias, K., Borusiak, B., & Szymkowiak, A. (2022). The role of knowledge about water consumption in the context of intentions to use IOT water metrics. *Frontiers in Environmental Science*, *10*. https://doi.org/10.3389/fenvs.2022.934965

National Bureau of Statistics (2022). *Public water supply and sewerage systems*. https://statbank.statistica.md/PxWeb/pxweb/en/10%20Mediul%20inconjurator/ (in Romanian)

National Bureau of Statistics (2023). *Number of population by age group at communes level on 01.01.2023*. https://statbank.statistica.md/PxWeb/pxweb/en/10%20Mediul%20inconjurator/ (in Romanian)

National Research Council of USA. (2004). *Estimating Water Use in the United States: A New Paradigm for the National Water-Use Information Program (2002).* National Academies Press. Washington. 190 p.

State Hydrometeorological Service (1977-2022). *Hydrological Yearbooks*. (in Romanian)

State Hydrometeorological Service. (2019). *Note on the status and evolution of surface water resources.* http://www.meteo.md/images/uploads/gis/hydro/hydro_description.pdf

U.S. Geological Survey. (2018). *Groundwater Wells completed*. Groundwater Wells. https://www.usgs.gov/special-topics/water-science-school/science/groundwater-wells

Van der Gun, J. (2021). Groundwater resources sustainability. In A. Mukherjee, B. Scanlon, A. Aureli, S. Langan, H. Guo, & A. McKenzie (Eds.), *Global Groundwater: Source, Scarcity, Sustainability, Security, and Solutions* (pp. 331–345). https://doi.org/10.1016/b978-0-12-818172-0.00024-4

Water Agency of Moldova (2023). *Water use in the Republic of Moldova*. Annual reports (2003-2022) Preprint. (in Romanian)

Water Law No 272 of 23.12.2011. In *Official Monitor* no. 81 of 26.04.2012. https://www.legis.md/ (in Romanian)