

The achievements, priority problems and measures in the development of public water supply and sewage systems in the North Development Region of the Republic of Moldova

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Abstract: The North Development Region has the lowest level of access to public water supply and sewage systems among the development regions of the Republic of Moldova. Only about ½ (52%) of the present population of the study region has access to public aqueducts, including 84% in urban areas and only 34% in rural areas. Also, only ≈20% of the population from North Development Region has access to public sewage systems, including 55% - in the urban areas and ≈1% - in the rural areas. Usually, the construction works of public water supply systems in rural areas are not accompanied by the construction of sewerage networks. The lowest access of the population to public water supply and sewage systems is caused, in particular by the difficult economic situation and the predominantly rural character of the region; by the reduced capacity of LPAs to co-finance projects in the field and by incomplete allocation of approved financial means and partial implementation of many projects. In this study were applied statistical and analytical methods, including systemic analysis and SWOT analysis, cartographic and comparative methods. In order to identify the priority measures in the field were taken into account both the specific objectives and the actions stipulated in the sectoral strategic documents, as well as the need to apply the basin principle of water resource management and the principle of regionalization of public water supply and sanitation services. For this purpose, were selected 3 agglomerations each, from the Prut river basin and from the Dniester river basin.

1. Introduction

The Dniester and Prut rivers are the most important sources of drinking water, but their exploitation capacities are limited. Groundwater reserves are sufficient in the most districts, with the exception of Glodeni, Briceni, Soroca and Ocnița districts, being influenced by the operation of the Dniester's hydro-power complexes (upstream of Naslavcea village) and Costești-Stanca – on the Prut River. The absolute majority of districts and rural localities are supplied from underground sources, however, in many localities, the flows of local sources are insufficient and the water quality is non-compliant. Despite the higher level of urbanization and industrialization, higher financial assurance and relatively rich water reserves, North Development Region (DR) has the lowest level of access to public water supply and sewage systems among the development regions of the Republic of Moldova. This fact has a significant impact on the socio-economic development and on the quality of life of the population from the study region. The current situation in this field is a major challenge and an area of priority

intervention of public policies at the regional and local level. In addition, the existing problems of public water supply and sanitation systems result in a significant impact on natural ecosystems and their components, especially on water resources, but also on the health and quality of life of the population in the study region.

The intensification of climate changes requires the implementation of sustainable use policies and efficient management of water resources available for the Republic of Moldova (OECD, 2013), in particular for North Development Region. In 2015, the United Nations General Assembly adopted the Sustainable Development Goals, the sixth goal is „Ensure access to water and sanitation for all” (UN, 2015). The water supply and sanitation sector are frequently perceived as a vulnerable for investment, particularly due to its sensitivity to external economic and socio-political disruptions (OECD, 2009). This context is characterized by inadequate regulations, institutional discontinuity and limitations in the provision of reference data, significant aspects affecting this field. Globally one of the biggest challenges to sustainable development is lack of access to improved water supply and sanitation services (Takala, 2017). Divergences in economic objectives, such as full cost recovery versus ensuring affordable tariffs, and social constraints, such as the preponderance of low incomes and the perception of water as a vital necessity, combine into an amalgam of conflictual problems whose importance varies by regions and states of the world (Blanc, 2007). Also, studies about status and use of public water supply and sanitation systems is reflected in recent analytical studies coordinated by OECD (2012, 2013, 2019), Environmental Protection of International River Basins (EPIRB, 2016), European Union Initiative for Water (EUWI+, 2020), in the Management Plans of Danube river (2021), Dniester Hydrographic District (Government Decisions (GD) of Republic of Moldova (RM) No. 814, 2017) and of Danube Prut and Black Sea Hydrographical District (Bejan et al., 2017), and of Camenca river basin (Bejan et al., 2019), in the national (GD of RM No. 119, 2014 and GD of RM No. 1063, 2016) and in the regional sectorial program (Norh RDA, 2022) as well as in the scientific researches, including of the authors of this study (Bacal et al., 2017, Bacal et al., 2020, Bacal et al., 2021, Bacal et al., 2022, Burduja et al., 2020, Burduja et al., 2022,).

The purpose of the research presented in this article is to evaluate the priority problems of the public water supply and sanitation systems in the Northern Development Region of the Republic of Moldova and to identify recommendations for mitigating the respective problems. The main objectives of the study are: 1) evaluation of the current status of the public water supply and sewage systems and their main components; 2) identification of priority issues in the provision of water to the population and in the development of public water supply systems; 3) assessment the access of the urban and rural population to the public supply systems of water supply and sewage systems and the level of their use; 4) identification of achievements and current problems of the operation of public sewerage and purification systems; 5) development of recommendations to mitigate the identified problems and to develop the public water supply and sanitation systems. In the present study, in order to identify the priority measures in the field were taken into account both the specific objectives and the actions stipulated in the sectoral strategic documents, as well as the need to apply the basin principle of water resource management and the principle of regionalization of public water supply and sanitation services. In this purpose, they have been selected 3 agglomerations from the Prut river basin (on the Cuihur, Racovăț and Vilia river basins) and 3 agglomerations from the Dniester river basin - on the axes Soroca-Dondușeni-Ocnița, Soroca-Bălți-Sângerei and Soroca-Florești-Șoldănești.

Implementation of GIS models in water supply and sewage systems helps the understanding of the data, analysis and query them using advanced technologies that can significantly improve the work in the field of urban planning. Using GIS models, viewing, editing, updating, localization and data processing can be done both at the office and in the field, so it reduces cost and time (Lateș, et al., 2016).

2. Materials and Methods

The main materials that served to carry out this study were: 1) The Data and Reports of the National Bureau of Statistics on the public water supply and sewage systems; 2) The Reports of the National Bureau of Statistics on population and demographic processes; 3) Annual Reports of State Inspectorate for Environmental Protection; 4) Yearbooks regarding the quality of environmental factors and the activity of the Ecological Inspections from the North DR; 5) Annual Reports "Financial and production indices of the enterprises of the "Moldova Water-Sewage" Association; 6) National Ecological Fund; 7) The Management Plans of the hydrographic basins (2017-2019); 8) Regional Sectoral Program for Water Supply and Sewerage of the North DR (2014); 9) Regional Operational Program of North DR (2022); 10) analytical studies in the field. The study period covered the 2010-2022 years.

In this study were applied statistical and analytical methods, including systemic analysis and SWOT analysis, as well as cartographic and comparative methods. The statistical methods were applied for processing of data on the dynamics of water supply and sewage systems and of its main components, evolution of the present population and its access to public water supply and sanitation systems in urban and rural areas.

The analytical method was used for: a) to identify quantitative and qualitative aspects of public water supply and sewerage systems; b) diagnosis of situation of water use and elaboration of recommendations to prevent problematic situations in this field; c) definition of priority directions of activity optimization of water resources management at regional and local levels. SWOT analysis method is applied for identification of problems and opportunities regarding the state and management of water supply and sewerage systems. The systemic analysis was used for complex assessment of water supply and sanitation systems, establishing cause-effect relationships. The comparative method was used for evaluating the dynamics and tendencies of developing of water supply and sewage systems from North Development Region from Republic of Moldova.

The cartographic methods, including based on GIS techniques was applied for the spatial representation of administrative organization of North DR and of water supply and sanitation systems and for elaboration of the respective spatial typology.

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3. The study area

According to Law of the Republic of Moldova no. 438 of 28.12.2006 on regional development, the North Development Region includes 11 districts and the municipality of Balti (Figure 1). The total area of the region is 10,014 km² or 31% of the total area of the Republic. The total number of the present population is 875 thousand inhabitants (NBS, 2023), including the urban population 304 thousand (35%) and the rural population – 571 thousand (65%). The economic and political-administrative center of the Northern DR is Bălți municipality, with a population of 126 thousand inhabitants.

The rest of the cities are small and medium-sized and include, mainly, the administrative residences of the districts, and in their suburbs, predominate the houses of individual households and small housing blocks. Among them are the cities of Soroca (34.3 thousand inhabitants), Edineț (17.9 thousand inhabitants), Drochia (16.7 thousand inhabitants) and Făleşti (16.4 thousand inhabitants). Also, in the Northern DR there are small towns, formed on the site of the old fairs, including Lipcani from the Briceni district, Mărculești and Prodănești from the Florești district, as well as small mono-industrial towns founded in the Soviet period, such as Otaci and Frunză from Ocnița district, Biruința from Sângerei district (Law of RM no. 764 of 27.12.2001 on the administrative-territorial organization of the Republic of Moldova).

Most of the study region is within the boundaries of the Răut river basin (the main right tributary of the Dniester river), including the districts of Dondușeni, Soroca, Drochia, Florești, Sângerei, and municipality of Bălți. The western part of the region is located in the Prut river basin, including the districts of Briceni, Edineț and Glodeni and most of the territory of Fălești (80%) and Râșcani (60%) and Ocnîța districts.



Figure 1. North Development Region, administrative map

4. Results and discussion

4.1 The public water supply systems

4.1.1 The main achievements of extension of public water supply systems

In the North DR, the number of public water supply systems increased, in the years 2010-2022, by 2.7 times (from 127 to 346), and the recent growth rates are the highest among the development regions of the Republic of Moldova. In the rural area, is observed an increase by 3.3 times (from 98 to 319 units), and in the urban environment it decreased by 2 units (Figure 2).

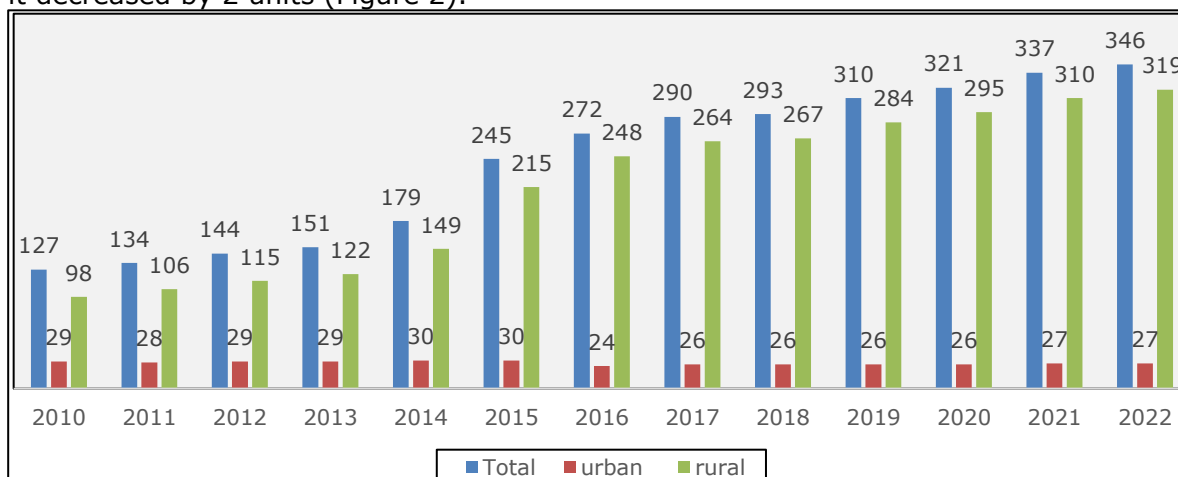


Figure 2. Dynamics of the number of public water supply systems in the North DR

The positive dynamics is manifested in the all districts of the region. The maximum increase can be seen in the districts of Soroca – by 12 times (from 2 to 24 units), Fălești – by 11 times (from 3 to 34 units), Râșcani (by 5.8 times), Edineț (by 5.4 times) and Dondușeni (by 5.0 times), and the minimum increase – in the Ocnița (by 1.2 times) and Glodeni (by 1.3 times) districts.

In 2022, the maximum number of public aqueducts were operated in the districts of Sângerei (56), Florești (53) and Râșcani (52), and the minimum number – in the districts of Dondușeni (15), Ocnița (6) and in the municipality of Bălți (3) (National Bureaux of Statistics, 2023).

The total length of public aqueducts from North DR is ≈4.4 thousand km, including 3.2 thousand km (73%) in the rural area and 1.2 thousand km (27%) – in the urban area (Table 1). The total length of public aqueducts increased by 2.4 times (2.5 thousand km), including in the rural area – by ≈5.0 times or with ≈2.5 thousand km (Figure 3).

Table 1. Status and use of public water supply systems in the Northern DR (2022)

TAU	Units			The length of the public aqueducts, km			No. of connected population			Access to the public aqueducts, %		
	T*	U*	R*	T	U	R	T	U	R	T	U	R
1 Briceni	25	4	21	234	88,9	145	18,1	9,2	8,9	26	72	16
2 Ocnița	6	4	2	90,3	63,7	26,6	8,8	8,4	0,3	18	48	1,0
3 Edineț	27	3	24	328	121	207	31,8	17,1	14,7	42	67	29
4 Dondușeni	15	2	13	193	43,7	150	13,0	4,7	8,3	33	54	27
5 Soroca	24	2	22	416	175	241	44,0	31,8	12,2	49	92	22
6 Drochia	24	1	23	492	89,4	403	32,4	14,2	18,2	42	85	30
7 Florești	53	3	50	627	125	503	39,3	15,4	23,9	50	94	39
8 Sângerei	56	3	53	521	67,7	454	49,3	14,5	34,8	61	91	53
9 Râșcani	52	2	50	505	60,6	444	45,7	13,6	32,1	76	99	67
10 Glodeni	27	1	26	295	40,2	255	26,5	8,5	18,0	50	90	42
11 Fălești	34	1	33	390	47,2	342	38,3	15,7	22,7	47	96	34
12 Bălți	3	1	2	273	244	28,9	107	104	3,1	85	86	66
North DR	346	27	319	4364	1167	3198	458	257	197	52	84	34

T=Total, U=Urban, R=Rural

Data source: National Bureaux of Statistics, 2023.

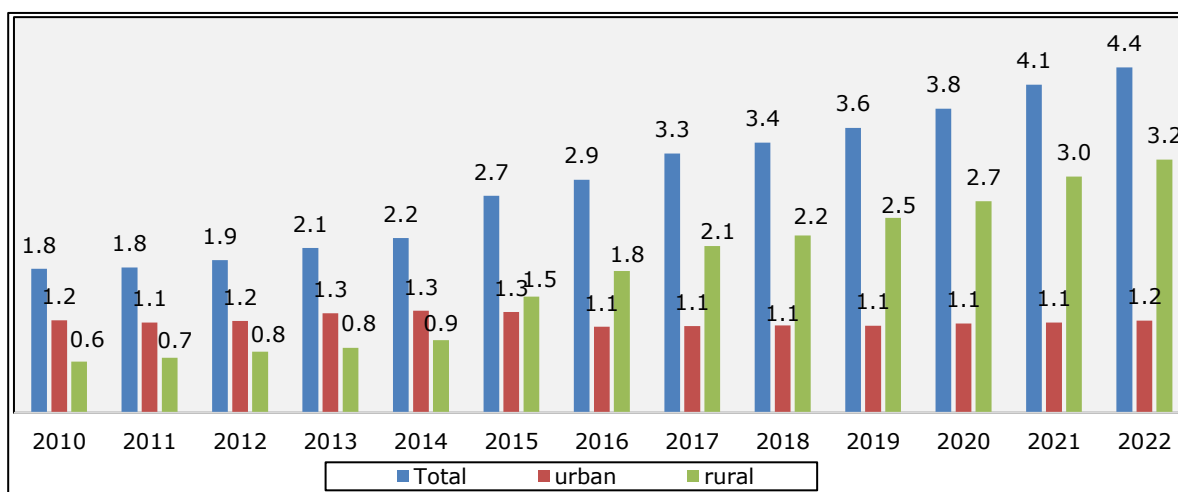


Figure 3. Dynamics of the length of public water supply systems in the North DR, thousands km

The doubling of the length of public aqueducts is observed in 8 of the 11 districts of the region. The highest rates of growth can be seen in the districts of Fălești (8.3 times),

Râșcani (4.4 times), Drochia (4.1 times) and Dondușeni (3.6 times), and the minimum growth – in the Balti municipality (+7%), Ocnita (+16%) and Briceni (+48%) districts. In the urban area, there is an oscillating evolution, on the background of a negative dynamic in recent years, including in the city of Balti, Glodeni and Florești, caused by the disconnection of enterprises from the public water supply system (NBS, 2023). At present, in the urban area, predominates the work of connecting of the new neighbourhoods, the suburban towns merged with the respective district centers, as well as the work of modernizing the aqueducts and connecting to the main aqueducts for transporting water captured from the Dniester and Prut riverbeds (Bacal et al., 2022).

In the years 2010-2021, from the National Ecological Fund, in the water supply and sanitation sector were approved for financing more than 100 investment projects, in the amount of 600 million MDL (NEF, 2022). The absolute majority (90%) of the executed works were intended for the construction and expansion of rural public aqueducts. Also, most projects were divided into several stages (3-5), being approved and financed separately (Bacal et al., 2021). Also, in the 2011-2023 years, by North Regional Development Agency (RDA) were implemented 22 projects in the field of water supply and sewage, in the total amount of 462 million MDL (24 million Euro), of which 212 million MDL (11 million Euro) were allocated from the National Regional Development Fund (FNDR). European Union funded 12 projects, in the amount of 228 million MDL (≈12 million Euro). The contribution of LPAs of level I and II constituted 22 million MDL (1.1 million Euro).

In recent years, they have been successfully implemented the big projects for connecting the Sângerei city to the Soroca-Bălți main aqueduct (North RDA, 2023), as well as of some adjacent localities to the respective aqueduct in the districts of Soroca, Florești and Sângerei, which allowed a significant increase to the access of the population from these districts to quality water supply services at a relatively low price.

As a result of the recent rapid expansion of the public aqueducts network, about 1/2 (52%) of the population from the Northern DR has access to public aqueducts, including 83% in the urban environment and only 34% – in the rural environment (NBS, 2023).

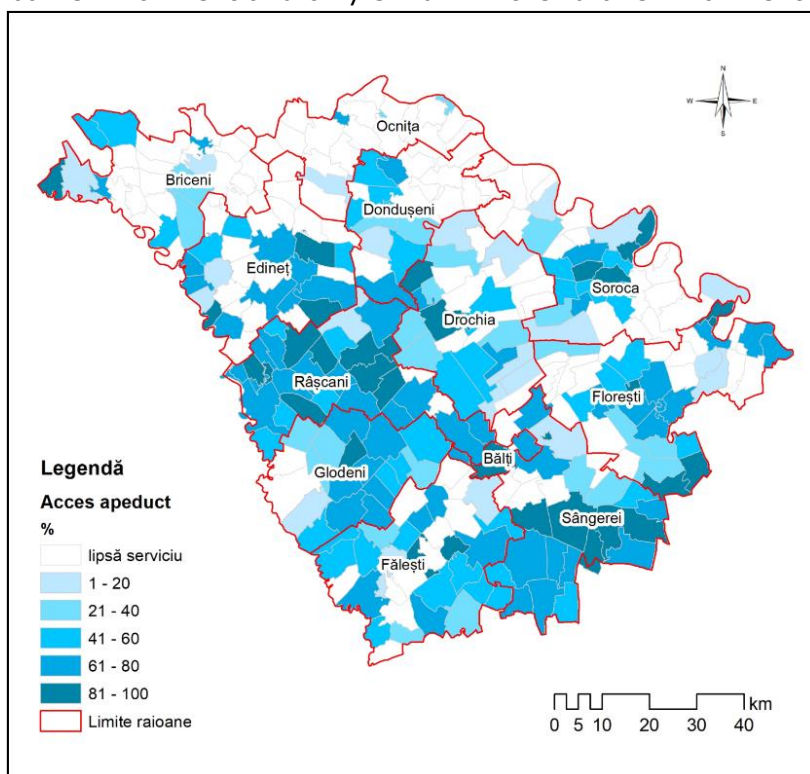


Figure 4. Access of population to the public aqueducts in the localities of the North DR %

4.1.2. The priority problems of water supply sector from North DR

Despite the recent rapid extension of water public networks, North DR has the lowest levels of access to public water supply systems among all development regions of the Republic of Moldova, and the absolute minimum is found in the Ocnița (18%), Briceni (26%), Dondușeni (33%) and Soroca districts (Table 1, Figure 4), especially in their rural localities. Wells and springs are the main source of water in rural areas, and the extracted water do not correspond to the sanitary-hygienic norms (State Inspectorate for Environmental Protection, 2018-2022). In some districts, such as Glodeni, Fălești, Briceni, Soroca, underground water reserves are insufficient and vary significantly depending on the amount of atmospheric precipitation (Burduja, 2022).

Despite the higher level of urbanization, in the Northern DR predominates the rural population (65%), small and medium-sized towns. North DR also has the most unfavourable geodemographic situation among the development regions of the Republic of Moldova, including the highest aging rate (22%), the highest general mortality rate (17.1‰) and the lowest birth rate (10‰), the lowest natural balance (-7.0‰), and migration processes are much more intense (NBS, 2023). In addition, the reduction of the birth rate and of natural balance started much earlier than in the other regions. The critical situation can be seen in small and medium-sized villages, particularly widespread in the northern districts, especially in Fălești, Glodeni, Soroca, Dondușeni, Ocnița.

The critical geodemographic situation significantly affects the socio-economic development of localities and the financial capacity of LPAs to co-finance projects in the field. Also, the existing technical and financial capacities are insufficient for capturing and transporting water from the Dniester and Prut rivers, connecting the population from the localities adjacent to the main aqueducts. In addition, LPAs insufficiently cooperate with each other in promoting inter-municipal and regional projects.

In the 2017-2020 years, there are frequent cases in which the approved amounts were not transferred, and ongoing projects were stopped (NEF, 2018-2021). Per total, $\approx \frac{1}{4}$ of the approved amount was not transferred, and the maximum share of the non-transferred balance can be seen in the Drochia, Fălești, Râșcani and Sângerei districts, which also benefited from the most projects. The poor implementation of the projects is due, to a certain extent, to the financial aspect represented by the non-coverage of the mandatory co-financing, which constitutes 15% of the total value of the investment.

Analysing the projects approved from the National Ecological Fund (NEF, 2022) in the North DR, we found that the persistence of public financing and the finished of investment contracts indicate the presence of multiple obstacles in the implementation of the projects in this field. These obstacles may include failure to collect the mandatory co-financing of 15% per project, incorrect estimation of the investment cost at the time of project submission, inflation, lack of necessary materials on the domestic market and bureaucratic problems, leading to the expiration of the contract term and requiring its extension. In 2022, the execution term was extended for 9 contracts in the North DR.

The lack or insufficiency of financial means for the construction of internal water supply networks is a major problem for LPAs in all development regions of the Republic of Moldova. Despite major investments in the construction of main aqueducts, of pumping stations, of towers and water tanks, due to the lack or insufficiency of financial sources for the construction of internal water supply networks, many projects are not finished, and the population of the respective villages do not benefit by safe and quality water sources. The respective problem is frequently attested in small villages, which, for financial reasons, are excluded from the area of implementation of projects in the field. The population number of these villages is very small (several tens or hundreds of inhabitants), with the detached predominance of socially-vulnerable persons of the 3rd age and incapacity to pay for public water supply services. For these reasons, the volume of water supplied in the respective localities is very low, and the cost of 1m³ of delivered water is much higher, which causes a reduced profitability of the operators and significant interventions from the deficient local budgets. In the Northern RD, similar

cases are attested in the districts of Glodeni (Balatina and Cuhnești town halls), Fălești (localities adjacent to the Prut-Fălești aqueduct), Florești, Drochia (North RDA, 2023).

Most public water supply systems in rural areas do not have functional water treatment plants or are used only episodically, usually before planned inspections. At the same time, only about ¼ of the project capacities of the existing pumping stations are used (AMAC, 2021), a fact that is explained both by the advanced degree of wear and by the multiple reduction of water use in agriculture and industry. A large proportion of water supply systems are inefficient due to design deficiencies, which generate high operational costs. The systems for monitoring and controlling capture, transport and consumption of water are non-functional or missing. As a result, the water delivered to rural consumers often does not meet the sanitary and hygienic standards, especially in terms of hardness, the content of fluorine, boron, hydrogen sulphide. In addition, there is a large number of unexploited artesian wells in an advanced state of wear.

Another problem frequently encountered in rural areas is the excessive use of water for purposes other than households, including for irrigation or for car washing, which generates deficiencies in the water supply of the rural population, its delivery for short periods of time and with frequent interruptions, especially during stronger droughts.

4.1.3. The key recommendations for water supply sector of North DR.

4.1.3.1. Expansion of distribution capacities of water abstracted from the Dniester riverbed.

This recommendation provides for the expansion of the main aqueducts from the Soroca-Bălți on the directions Soroca-Dondușeni-Ocnița, Soroca-Șoldănești (riverine localities southeast of the Soroca city), Bălți-Sângerei and Bălți-Râșcani, as well as connecting of the adjacent villages to the main aqueduct Soroca-Bălți and to its proposed extension. The achievement of these measures will significantly contribute to increasing the population's access to public aqueducts and to quality water, especially in the localities along the Dniester River in the districts of Soroca, Dondușeni and Ocnița. For this purpose, the North Regional Development Agency (RDA, 2023), has started the implementation of a large-scale project for the supply of water from the Dniester River to 41 localities in the districts of Soroca (21), Dondușeni (10) and Ocnița (10), in amount of 13.0 million MDL (674 thousand Euro). As a result of the implementation of the Project, 63.5 thousand people will be able to benefit from quality water abstracted from the Dniester riverbed, including 28.5 thousand in Ocnița district, 20.4 thousand in Dondușeni district and 14.7 thousand in Soroca district. In addition, it is recommended to expand the respective aqueduct in the Ocnița district localities located in the Prut river basin (on the Ciuhur river valley). Also, in the Soroca district, has started the implementation of the water supply project for 4 riverside communes (7 localities) located southeast of the city of Soroca, in the amount of 30.5 million lei. This project provides the construction of the main adductions for connection of over 11 thousand people and a rest camp for children with 1500 places. The successful implementation of these 2 projects will significantly contribute to increasing the population's access to quality water, including up to ≈60% in Ocnița district, ≈70% in Dondușeni district and 75% in Soroca district. Another great advantage of the respective Dniester water supply projects is the low cost (5.0 lei/m³) of the water delivered to the water supply network by the regional operator SA Acva Nord from the Soroca city and, respectively, the application of small quotas of these tariffs (AMAC, 2023) for the population of the connected villages, especially of the small ones, that are particularly numerous, especially in the Soroca district, for which the construction and operation of their own water supply systems is practically impossible. This adduction is recommended to be extended in the west – to the villages from the Drochia and Râșcani districts, as well as in the southeast – to the Florești and Șoldănești districts. with insufficient reserves of underground water. Also, LPAs of first and second levels from these districts must find

the necessary sources for the construction and operation of internal water networks. In this context, the efforts of the central public authorities responsible for this sector must be transposed as a priority in the complex governmental programs of regional and local development, in the sectoral programs, so that the basic objective - ensuring the majority of the population's access to quality water, is achieved within the established terms and on a planned scale.

4.1.3.2. Expansion of water distribution capacities captured from the Prut riverbed. This recommendation provides:

a) the construction of the internal water supply networks and the connection to the main aqueduct Prut-Fălești-2 of the Fălești town and of the adjacent rural localities, especially from the Șovașul Mic and Gârla Mare river basins. The main aqueduct Prut-Fălești-2 was recently built (2020), but it is still not put into operation and the source of quality water from Prut riverbed is not exploited.

b) the construction of the new main aqueduct Prut-Glodeni from the new pumping station of Balatina village. The realization of this measure would allow the connection of the Glodeni town and the adjacent rural localities to the respective aqueduct, the multiple increase of the quantity of quality delivered water, the establishment of lower quotas for the tariffs for water supply tariffs, ensuring the profitability of the regional operator, reducing the impact on the human health and on the environmental components. A welcome solution for many localities in the Prut river basin would be the entry into the water supply and sewerage services market of SA Apa Vital Iași, but these measures must be well coordinated so that some activities are not overlapped and others are ignored, no less important (EUWI+, 2019).

c) building and extension of the internal water supply networks and connecting of localities adjacent to the main Prut-Edineț aqueduct, especially in the Racovaș river valley.

It is absolutely necessary to declare the main aqueducts, which distributes the water captured from the Dniester and Prut rivers, as national security objectives and apply a rigorous control over their status and operation.

4.1.3.3. Expanding the distribution capacity of water captured from underground sources.

Expanding the distribution capacity of water captured from underground sources, especially from springs with high flow and quality water from Drochia, Florești and Ocnița districts. The springs from the villages of Cotova (over 100) and Mândâc from Drochia district, are known for their high-water flows, being widely used for the water supply of the local population. The springs at the border of Naslavcea and Bârnova communes in Ocnița district have a high flow rate (18 l/min), and their water is of very good quality. Even if the main aqueduct from Soroca will be extended to the town of Ocnița, the restoration of the Naslavcea-Ocnița aqueduct is a sustainable alternative. The district public authorities and of the mentioned communes are actively promoting the idea of restoring the respective aqueduct, the water pumping and distribution infrastructure. The Florești district is also rich in springs with high flow and quality water, among which we mention the springs from Gura Cainarului (mineral water is extracted for bottling), the riverside towns of the Nistru river (Japca, Târjul Vertiujeni, Vertiujeni, Zolonceni, Vășcauți, Cuhureștii de Sus and Cuhureștii de Jos), in which, in the years 2017-2020, by North DRA was implemented a water supply project extracted from underground springs, but which was not carried out in the last 2 mentioned villages.

4.1.3.4. Regionalization of water supply services based on river basin agglomerations. This recommendation including:

a) The construction of public aqueducts in the localities from the Ciuhur 1 river basin (the villages of Ocnița, Dânjeni, Mihălășeni, Grinăuți-Moldova and Bârlădeni), which would allow the connection of 10.8 thousand inhabitants of the Ocnița district at a total

cost of 49.7 million MDI or 2.6 million Euros. As mentioned above, this section is proposed to be connected to the planned main aqueduct Soroca-Ocnița (EUWI+, 2020);

b) The construction of public aqueducts in the localities from the Ciuhur 2 river basin, which would ensure access to 5.3 thousand people from the Edineț district (the villages of Alexeevca, Terebnea, Stolniceni) at a total cost of 24.6 mil. MDI or 1.3 mil. Euros;

c) The construction of public aqueducts in the localities from the Racovaț river basin, including Clocușna, Hădărăuți, Corestăuți of the Ocnița district, Marcăuți, Bălcăuți, Halahora de Sus and Mihăileni from the Briceni district. The project will cost 43.2 million MDL or 2.2 million Euros and will ensure the connection of 9.4 thousand inhabitants.

d) Construction of public aqueducts in the localities from Vilia river basin from Briceni district, at a cost of 45.9 million MDL or 2.4 million Euros.

4.2. The public sanitation systems.

4.2.1 The priority problems of sanitation sector from North DR.

4.2.1.1 Very low access to public sewage and wastewater treatment systems.

In the North Development Region there are only 52 public sewage systems or by ≈ 7 times less than the public water supply systems (346). Only $\approx 20\%$ of the region's population has access to public sewage systems, including 55% – in the urban areas and $\approx 1\%$ – in the rural areas. In most districts there are no public sewage systems in rural areas (figure 4). If the number of public water supply systems registers a rapid increase, then the number of public sewage systems registers a general negative dynamic, which is manifested in about half of the districts of the region (Bacal et al., 2022). As a result, the degree of coverage of water supply systems with sewage systems decreased during the analyzed period from 45% to 15% (NBS, 2023).

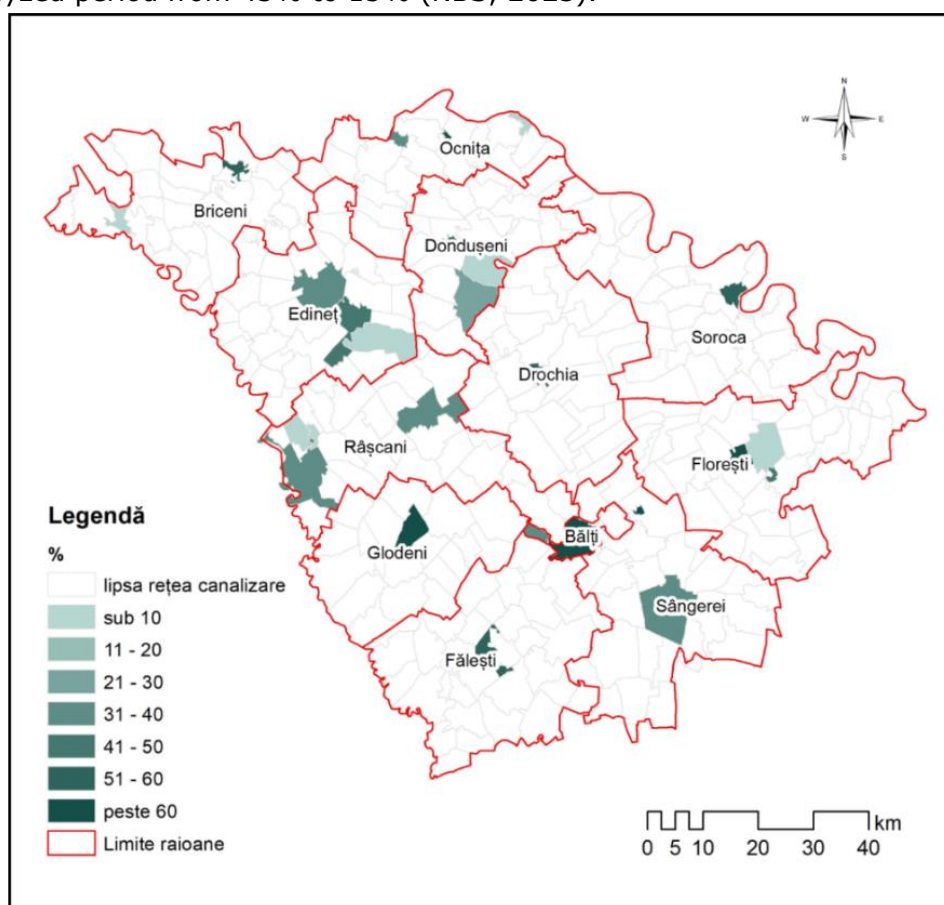


Figure 5. Access of population to the public sewerage systems in the localities of the North DR, %

The length of the sewage systems in the North DR is ≈ 600 km, including 548 km (92%) in the urban area and only 52 km – in the rural area (NBS, 2023). In the 2022 year, the maximum length of the public sewerage networks can be seen in the municipality of Bălți (157 km or 26% of the North DR), as well as in the districts with larger urban centres, including Edineț (55.2 km), Soroca (54.8 km) and Florești (52.1 km), and the minimum length – in the districts with smaller urban centres, including Ocnîța and Glodeni districts (18.2 km each), Dondușeni (27.4 km).

4.2.1.2. The higher cost for construction of sewage systems and the neglect of the LPAs and the rural population towards the issue of wastewater disposal and treatment.

Usually, the works of construction and expansion of public water supply systems in rural areas are not accompanied by those of construction and expansion of sewerage networks. The lack of progress in the expansion of centralized sewerage systems is largely caused by the higher costs compared to water supply systems, and the majority of the rural population and LPAs do not consider this need to be a priority (Bacal et al., 2021). A good part of the drainage and purification systems have an advanced degree of wear, and the received waste water is insufficiently purified, which significantly increases the harmful impact on water resources and on the human health.

4.2.1.3. The massive lack of sewage treatment plants and the increased degree of wear of the functional plants.

The number of sewage treatment plants decreased during the analyzed period from 42 to 34 units, of which only 21 have functional sewage treatment systems. The sewage treatment plants do not work in the cities of Soroca and Glodeni, as well as in the absolute majority of rural localities from North DR. More than 80% of the total volume of waste water discharged by public sewage systems is passed through treatment plants and subjected to complex treatment (SIEP, 2021). Pumping stations, wastewater discharge and reception networks, as well as treatment plants have a long operating life, a high degree of wear and low profitability. Of the total number of treatment plants, none complies with the requirements of Council Directive 91/271/EEC of 21 May 1991 on the treatment of urban waste water. The reconstruction and modernization of sewage treatment plants must also take into account the need for additional removal of nitrogen and phosphorus.

4.2.2. The key recommendations for sanitations sector of North DR.

4.2.2.1. Construction of sewage treatment plants in the cities of Soroca, Glodeni, Florești and Fălești.

In 2022, North RDA started the construction projects of the regional sewage treatment plants in the cities of Glodeni and Florești. The construction of the regional sewage treatment plant and the expansion of the Glodeni sewage network will cost 20.7 million MDL (1.1 million Euro) and will allow access to modern sanitation systems for the inhabitants of the city of Glodeni (9.3 thousand) and the villages of Hâjdieni (3.4 thousand), Dușmani (1.7 thousand) and Danu (3.0 thousand) from its proximity. The construction project of the Florești regional sewage treatment plant will cost 32.7 million MDL (1.7 million Euro) and will also include the expansion and modernization of the sewage network and its main components. In addition, in September 2023, the land was approved (near the village of Vasilcău) for the construction of the Soroca regional sewage treatment plant, which would allow access to more than 40 thousand people. Despite the very advanced state of wear and the very harmful impact of the water discharged from the sewage treatment plant on the receiving aquatic objectives, the start of the construction of a new sewage treatment plant in Fălești is delayed. The main cause is the lack of financial sources for the respective project, despite the repeated efforts of the District Council and of the Fălești Municipality in this regard and the feasibility study developed for this purpose.

4.2.2.2 Construction of sewerage systems based on river basin agglomerations, including:

Construction of the sewage system in the localities from Ciuhur 1 river basin in Ocnîța district, at a total cost of 43.3 million MDL or 2,2 million Euros (EUWI+, 2020);

Construction of the sewage system in the localities from the Ciuhur 2 river basin in Edineț district - at a total cost of 21.5 million MDL or 1,1 million Euros;

c) Construction of the sewage system in the localities from the Racovaț river basin in the Briceni and Edineț districts, at a total cost of 37.7 million MDL or ≈2,0 million Euros;

d) Construction of the sewage system in the localities from Vilia river basin, Briceni district, at a total cost of 40.2 million MDL or 2,1 million Euros;

4.2.2.3. Renovation of the sewage treatment regional plant.

Renovation of the sewage treatment regional plant in the towns of Sângerei (about 30 million MDL/1,6 mil. Euro) and Dondușeni (≈20 milion MDL or 1,04 mil. Euros)

4.2.3.4 Regionalization of Water Supply and Sanitation services and the application of market principles in this field.

Water policymakers frequently express concern about the affordability of water and sanitation services, particularly for low-income households. Concerns about affordability are often the main argument for keeping water prices low. This concern derives from the desire to ensure that water and sanitation services are available and accessible to all citizens, regardless of their income level (Fuente et al., 2016). In particular, the focus is on protecting and supporting low-income households, as they may be the most affected by high water rates. By keeping water prices low, policymakers aim to provide the opportunity for low-income households to benefit from essential water and sanitation services, which are considered vital necessities. This aims to ensure a minimum level of quality of life and help reduce social inequalities. However, keeping water prices low can present challenges and repercussions. It is important that these decisions are balanced with the financial sustainability of the water sector to ensure investment in infrastructure, adequate maintenance of systems and the provision of quality services. Therefore, tariff policy in the water sector must find a balance between affordability and sustainability, for the benefit of all citizens.

Cost recovery through the combination of taxes, tariffs and transfers (3T) in association with Public-Private Partnerships (PPPs), as well as the use of capital market instruments, are more and more widespread (Libey, 2020) In this context, national governments and international donors should realize that long-term support of local water service provision is necessary, appropriate and likely to be more cost-effective than current funding models (OECD, 2012, 2019). Also, some studies (Shi, 2018) show that an integrated policy that combines a performance guarantee policy and a government subsidy policy can improve the efficiency of PPP infrastructure projects.

A solution to ensure the mandatory co-financing of projects and for the development of PPPs, could consist in the use of alternative financing through capital market instruments such as crowdfunding platforms. In the Republic of Moldova, there are crowdfunding platforms, which offer the diaspora the opportunity to contribute to improving the living conditions of the local population, and the locals can contribute through personal donations and by redistributing 2% of the income tax paid. An example of good practices in terms of co-financing through multi-financing platforms can be the project to create aqueduct systems in the Slobozia Mare, Cahul district of the South Development Region. This practice is not unique in the country and it would be beneficial to be adopted by other localities to solve the problem of co-financing projects to create and rehabilitate the water supply, sewage and purification systems.

5. Conclusions

In the last time, in the region of study is found a multiple increase of the number and length of public water supply systems. As a result, over 50% of the population from the North DR has access to public aqueducts, including 83% in the urban environment and only 34% – in the rural environment. Despite this fact, North DR has the lowest levels of access to public water supply systems among all development regions of the Republic of Moldova, and minimum access is registered in the north part of study region.

The key problems, which determines minimum access to the public aqueducts are: critical geodemographic situation, massive lack of financial sources at LPAs and rural population, predominance of socially-vulnerable persons of the 3rd age and their incapacity to pay for public water supply services, frequent cases in which the approved amounts were not transferred, massive lacks of water treatment plants and of monitoring equipment, insufficient cooperate of LPA for implementation of projects in this field, the excessive use of water for purposes other than households

The key recommendations for water supply sector from North DR are: elaborated in this study are: expansion of distribution capacities of water abstracted from the Dniester and Prut riverbeds; expanding the distribution capacity of water captured from underground source, especially from springs with high flow and quality water; regionalization of water supply services based on river basin agglomerations

The priority problems of sanitation sector are Very low access to public sewage and wastewater treatment systems; the higher cost for construction of sewage systems and the neglect of this problem by LPAs and of the rural population; paid incapacity of majority rural population for disposal and treatment of wastewaters; the massive lack of sewerage treatment plants and the increased degree of wear of the functional plants.

The key recommendations for sanitations sector from North DR are: construction of sewage treatment plants in the cities of Soroca, Glodeni, Florești and Fălești; construction of sewerage systems based on river basin agglomerations; renovation of the sewage treatment regional plant in the towns of Sângere and Dondușenii.

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References

1. Agenția de Dezvoltare Regională Nord (2022) *Programul Operațional Regional al Regiunii de Dezvoltare Nord*. Available online: <http://adrnord.md/>. (accessed on 25.02.2023)
2. ADR Nord (2023) *Program Regional Sectorial de Alimentare cu Apă și de Canalizare pentru Regiunea de Dezvoltare Nord*. Available online: <http://adrnord.md/>. (accessed on 25.02.2023).
3. Asociația „Moldova Apă-Canal”. *Indicii financiari și de producție ai activității întreprinderilor de alimentare cu apă și canalizare*. (2011-2020). Available online: www.amac.md. (accessed on 23.05.2023).
4. Bacal, P.; Burduja, D. (2017) Dynamics and branch structure of water consumption in the Republic of Moldova. *PESD*, 11(2), 187-201. <https://doi.org/10.1515/pesd-2017-0036>
5. 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. *Cent Eur J Geography Sustain Develop*, 4(1), 23-40. <https://doi.org/10.47246/CEJGSD.2022.4.1.2>
6. Bacal, P.; Lozovanu, D.; Matei, M. et al. (2020) *Regiunea de Dezvoltare Centru. Aspecte geografice, socio-economice și ecologice*. Editura; Dira Ap, Chișinău, 2020; 156 p.

7. Bacal, P.; Mogîldea, V.; Jeleapov, A. et al. (2021) *Starea și utilizarea sistemelor de aprovizionare cu apă și sanitație în ecosistemele urbane și rurale din Regiunea de Dezvoltare Nord a Republicii Moldova*. Editura „Impressum”: Chișinău, 2021; 162 p.
8. Bejan, I.; Nedeașcov, M.; Boboc, N.; Bacal, P. et al. (2017). *Planul de Gestionare a Districtului Hidrografic Dunărea-Prut și Marea Neagră. Ciclul I*; Chișinău, 2017; 150 p.
9. Bejan Iu. ; Bacal, P. ; Nedeașcov, M. et al. (2019). *Planul de Gestionare a Bazinului Hidrografic Camenca Ciclul II, 2019-2024*. Chișinău, 2019. 98 p.
10. Biroul Național de Statistică (2023). *Sisteme publice de alimentare cu apă și de canalizare*. Available online: statistica.gov.md (Accessed on 14.07.2023).
11. Biroul Național de Statistică (2023). *Numărul populației prezente pe grupe de vârstă la nivel de comune la 01.01.2023*. Available online: <https://statbank.statistica.md/>. (Accessed on 14.09.2023).
12. Blanc, D. (2007). *A Framework for Analyzing Tariffs and Subsidies in Water Provision to Urmab Households in Developing Countries*. Available online: https://www.un.org/esa/sustdev/publications/water_tariffs.pdf. (accessed on 04.06.2023).
13. Burduja, A.; Bacal, P.; Răileanu, V. (2020) The particularities of water use in the Central Region of Republic of Moldova. *Present Environment and Sustainable Development*, 14(1), 5-17. <https://doi.org/10.15551/pesd2020141001>
14. Burduja, D.; Bacal, P. (2022) *Evaluarea utilizării și gestionării resurselor de apă ale Republicii Moldova. Studiu de caz: RD Nord*. Editura „Impressum”: Chișinău, 2022; 200 p.
15. *Calitatea apei destinate consumului uman din rețele de apeducte urbane. Raport*. (2020). Editura Bons Offices: Chișinău, Republic of Moldova; 31 p. Available online: <https://www.serviciicomunale.md>. (accessed on 23. 06.2023).
16. Danube River Basin Management Plan 2015-2021. Available online: <https://www.icpdr.org/main/sites/brochure2015.pdf>. (accessed on 20.04.2023)
17. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Official Journal of the European Communities L 327/1, 22.12.2000. (accessed on 20.04.2023)
18. Environmental Protection of International River Basins (2012-2016). Available online: <https://www.euneighbours.eu/en/east/stay-informed/projects>. (Accessed on 23.05.2023).
19. Fondul Ecologic Național. *Listele proiectelor aprobate pentru finanțare din Fondul Ecologic Național în anii 2010-2022*. Available online: <https://www.mediugov.md/ro/content/fondul-ecologic-na%C8%9Bional>. (accessed on 30. 05.2023).
20. *Fondul National de date geospacial*. Available online: www.geoportal.md. (Accessed on 13. 05.2023).
21. Fuente, D.; Gatua, J.G.; Ikiara, M.; Kabubo-Mariara, J.; Mwaura, M.; Whittington, D. (2016) Water and sanitation service delivery, pricing, and the poor: Anempirical estimate of subsidy incidence in Nairobi, Kenya. *Water Resour Res*, 52(6), 4845-4862. <https://doi.org/10.1002/2015WR018375>
22. HG no. 814 from 17.10.2017 *cu privire la aprobarea Planului de gestionare a districtului bazinului hidrografic Nistru*. Monitorul Oficial no. 371-382/27.10.2017. Available online: <https://www.legis.md/cautare/get>. (accessed on 21.07.2022).
23. HG no. 199 from 20.03.2014 *cu privire la aprobarea Strategiei de alimentare cu apă și sanitație (2014 – 2028)*. In: Monitorul Oficial no. 72-77/28.03.2014. Available online: https://www.legis.md/cautare/getResults?doc_id=122590&lang=ro#. (accessed on 23. 02.2023).

24. HG no. 1063 from 16.09.2016 privind aprobarea Programului Național pentru implementarea Protocolului privind Apa și Sănătatea (2016-2025). Monitorul Oficial no. 314 din 20.09.2016. Available online: https://www.legis.md/cautare/getResults?doc_id=102596&lang=ro (accessed on 12.05.2023).
25. Inspectoratul pentru Protecția Mediului (2019-2023) Anuarele privind calitatea factorilor de mediu și activitatea Inspecțiilor Ecologice. *Preprint*.
26. Lateș, I.; Luca, M.; Ilie, G.; Iurist, N. (2016) Studies on the implementation of GIS model in Water Supply Systems. *Present Environment and Sustainable Development*, 10(2), 153–160. <https://doi.org/10.1515/pesd-2016-0033>
27. Legea apelor no. 272 from 23.12.2011. In: Monitorul Oficial no. 81 from 26.04.2012.
28. Legea RM no. 438 from 28.12.2006 privind dezvoltarea regională. In: Monitorul Oficial no. 21-24 from 16.02.2007. Available online: <https://www.legis.md/> (accessed on 17.02.2022).
29. Legea RM no. 764 from 27.12.2001 privind organizarea administrativ-teritorială a Republicii Moldova. In: Monitorul Oficial no. 16 from 29.01.2002. Available online: <https://www.legis.md/> (accessed on 17.02.2022).
30. Libey, A.; Adank, M.; Thomas, E. (2020) Who pays for water? Comparing life cycle costs of water services among several low, medium and high-income utilities. *World Dev*, 136, 105155. <https://doi.org/10.1016/j.worlddev.2020.105155>
31. OECD (2013) EAP Task Force. *Adapting Water Supply and Sanitation to Climate Change in Moldova*, Available online: <https://www.oecd.org/environment/outreach/Business%20models%20for%20rural%20sanitation.pdf> (accessed on 19.03.2019).
32. OECD (2019) *Enhancing the Economic Regulatory System for Moldova's Water Supply and Sanitation*. July 30, 2019. Available online: <https://www.oecd.org/publications/enhancing-the-economic-regulatory-system-for-moldova-s-water-supply-and-sanitation-8696bde7-en.htm> (Accessed on 19.05.2023).
33. OECD (2012) *Studies on Water Meeting the Water Reform Challenge. Executive Summary*. Available online: <https://www.oecd.org/environment/resources/49839058.pdf>. (Accessed on 19.05.2023).
34. OECD (2009). *Private Sector Participation in Water Infrastructure*. Available online: <https://www.oecd.org/env/resources/42350657.pdf>
35. Proiectul EUWI+ (2020) Planul de Gestionare a Bazinului Districtului Hidrografic Dunărea-Prut și Marea Neagră. Ciclul II. (2022-2027). Preliminary version, October 2020. Available online: https://euwipluseast.eu/images/2020/11/PDF/Full-RBMP-DPBS_RO.pdf. (Accessed on 02.08.2023).
36. Shi, L; He, Y; Onishi, M; Kobayashi, K. (2018) Efficiency Analysis of Government Subsidy and Performance Guarantee Policies in Relation to PPP Infrastructure Projects. *Math Probl Eng*, 2018, 6196218. <https://doi.org/10.1155/2018/6196218>
37. Sîrodoev, I.G.; Knight, G. (2008) Vulnerability to waters car city in Moldova: likely, threats for future development. *Present Environment and Sustainable Development*, 2, 6-14.
38. Takala, A. (2017). Understanding sustainable development in Finnish water supply and sanitation services. *International Journal of Sustainable Built Environment*, 6(2), 501–512. <https://doi.org/10.1016/j.ijsbe.2017.10.002>
39. United Nations. (2023) Water and sanitation - united nations sustainable development. Available online: <https://www.un.org/sustainabledevelopment/water-and-sanitation/> (accessed on 19.05.2023)



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