ACADEMY OF ECONOMIC STUDIES OF MOLDOVA

In right of manuscript
CZU: 556:332.1(478)(043.3)

BURDUJA DANIELA

ECONOMIC AND GEOGRAPHICAL ASPECTS OF THE VALORIZATION AND MANAGEMENT OF WATER RESOURCES OF THE REPUBLIC OF MOLDOVA

154.01 SOCIAL AND ECONOMIC GEOGRAPHY

Abstract of the PhD thesis in Earth Sciences

CHIŞINĂU, 2023

The thesis was developed at the Doctoral School of the Academy of Economic Studies of Moldova

Scientific adviser:

BACAL Petru, PhD in geography, associate professor.

Componența Comisiei de susținere publică:

1. **MATEI Constantin**, habilitated doctor in geography, university professor, Institute of Ecology and Geography – *President*;
2. **BACAL Petru**, PhD in geography, associate professor, Institute of Ecology and Geography – *Scientific adviser*;
3. **HACHI Mihai**, PhD in geography, associate professor, Academy of Economic Studies of Moldova – *Official reviewer;*
4. **EFROS Vasile**, PhD in geography, university professor, "Ștefan cel Mare" University of Suceava – *Official reviewer;*
5. **MUNTELE Ionel**, PhD in geography, university professor, "Alexandru Ioan Cuza" University of Iași – *Official reviewer.*

The defense will take place on February 17, 2023, at 13.00, during the meeting of the Commission for Public Defense of the doctoral thesis, at the Academy of Economic Studies of Moldova, at the address. Gavriil Bănulescu-Bodoni, 59, room 104, Block B.

The doctoral thesis and the abstract can be consulted at the Scientific Library of the Academy of Economic Studies of Moldova and on the website of ANACEC (www.cnaa.md).

The summary was sent on 17 January 2023.

Scientific adviser
PhD in geography, associate professor. **BACAL Petru**

Author: **BURDUJA Daniela**

CONTENTS

CONCEPTUAL REFERENCES OF THE RESEARCH

The actuality of the research topic. The relevance of the problems of developing research into the geographical and socio-economic aspects of water resource management, as a theoretical basis for the rational and efficient use of these resources, is determined by the level of involvement of water in economic activities and the degree of anthropogenic impact in the formation of a market economy. From this, results the actuality of research on the economic-geographical aspects of the use and management of water resources addressed in this paper. The basic premises, which determined the realization of this work, were: 1) the small number of complex scientific researches on water resources use and management in the Republic of Moldova; 2) the increasing economic impact on water resources; 3) the need for a comprehensive and up-to-date research on water resources use and management at the level of regions and river basins; 4) the evaluation of the economic mechanism of water resources management in regional profile.

Degree of study of the topic. A review of research in the field of water use and management has revealed that most often only certain aspects of water resources are addressed. Research on the specifics of water use and management is mostly found in the geographical and economic sciences. Thus, of great value are the works on: a) economic evaluation of water resources by T. Meleșkina [64]; b) use of natural resources - V. Anucin [58], B. Borovskih [62], N. Reimers [69]; c) economics of natural resource use - A. Neverov [68], T. Haciaturov [71], including water resources - Yu. Belicenco [60], M. Bestzenaya [61] and A. Savina [70]; d) water resources management - V. Băloiu [15], E. Constantin [28], Gh. Crețu [29], R. Dropot [31] and A. Gălie [36].

In the Republic of Moldova there is already valuable research on: a) environmental protection management by P. Bacal [6, 8, 10]; b) environmental management, including water resources - A. Capcelea [22-25]; c) economic and geographical aspects of water use –P. Bacal [7, 9]; d) surface water resources - Gh. Bejenaru [16, 17, 26], V. Cazac [26], A. Jeleapov [42] and O. Melniciuc [65, 66], and groundwater - B. Iurciuc [40], L. Chirică [27] and C. Moraru [48-50, 67]. Despite the existence of many valuable research studies, research on water resources assessment, use and management is currently quite fragmented and these issues have not been studied as a whole, which is why this study is necessary. Most often, only aspects of water quantity and quality are addressed, and water use and management are only superficially investigated.

The purpose of the research: Complex economic-geographical appreciation of water resources development and management of the Republic of Moldova.

The objectives of the research: 1) Creation of the informational and methodological support for the economic-geographical assessment of water resources development and

management; 2) Assessment of surface and groundwater resources in national, regional and basin profile; 3) Spatial (by administrative and hydrographic units) and branch analysis of water resources abstraction and use; 4) Assessment of the current water resources management mechanism and its main components; 5) Development of recommendations for sustainable use and more efficient management of water resources.

Research hypotheses. Insufficient knowledge of water resources use and management issues and inadequate application of management mechanisms, which hinder their rational use and protection, made it necessary to carry out this study, which provides a comprehensive scientific background to the current problem - water resources use and sustainable management, taking into account regional characteristics.

The novelty and scientific originality. A comprehensive study was carried out on the spatial and branch aspects of water resources use and management in the Republic of Moldova from an economic-geographical perspective, including a complex analysis of several indicators related to water use, as well as economic mechanisms for management and protection. A very rich database on water management indices has been accumulated from reports issued by the Moldovan Water Agency (MWA), the Environmental Protection Inspectorate (EPI), the National Bureau of Statistics (NBS). At the same time, has been created a combined database on the dynamics of the volume of water abstracted and used in order to eliminate the gaps detected in the sources mentioned.

The solved scientific problem consists in the complex spatial analysis at the level of administrative-territorial units of the distribution, use and management of water resources in the context of socio-economic changes and the intensification of climate changes. The particularities and trends of water use by categories of use and economic activities were evaluated. Also, the problems in the operation of water resources capture and distribution systems, as well as in the application of water resources management tools, were highlighted, with practical recommendations for their prevention and mitigation being proposed.

The theoretical significance. The thesis represents an interdiscplinary study, based on a complex assessment of water resources and their current use and management features in regional and basin profile. This work will contribute significantly to the updating and deepening of the local economic-geographical studies and the geography of natural resources in the Republic of Moldova.

The applicative value. Research results can be used in the development of hidrographyc District and Basin Management Plans, Regional Sector Programmes and Local Water Supply Action Plans. The results and database of this work can be very useful in the preparation of water supply progress reports, including policy documents on sustainable water resources development in the context of climate and socio-economic change.

Implementation of results. The results obtained were successfully used in the implementation of the institutional applied projects "Assessment of the stability of urban and rural ecosystems in order to ensure sustainable development" (2020-2023), and "Study of the impact of economic activities of the Central Development Region in order to protect the natural potential for ensuring sustainable development" (2016-2019), including in the project "Social and environmental impact study of the Dniester Hydropower Complex" (2021).

Approval of scientific results. The scientific value of the research has been confirmed in numerous scientific events, including: the International Symposium "Present Environment and Sustainable Development", Iasi (2017-2022); the International Geographical Seminar "D. Cantemir", Iasi (2017, 2019, 2021); Bălți (2017-2022), as well as in collective monographs and IEG Article Collections.

Scientific research methodology. Various methods were used during the research, starting from general ones (analytical, comparative, statistical, etc.) and going deeper into concrete geographical methods. The use of the SWOT analysis method has given the present work a pronounced practical importance, and the use of GIS techniques has made it possible to obtain cartographic material that more clearly shows the spatial particularities of water resource use and management.

Publications: 33, including 5 indexed in Web of Science journals.

Volume and structure of the thesis. The thesis consists of introduction, 5 chapters, conclusions and recommendations, a bibliography of 233 titles, 161 pages of basic text, 52 figures, 18 tables, including 41 anexes.

Keywords: water resources, abstraction, use, management, regions, river basins.

THESIS CONTENT

In **Chapter 1. „Theoretical and methodological aspects of water resources research",** is presented the theoretical, methodological and informational approach to the use and management of water resources in the Republic of Moldova. Thus, Water Resources Management involves the development and exploitation of water resources, taking into account hydrological conditions, technical aspects, as well as socio-economic, political and ecological aspects. The principles underlying water resources management in the Republic of Moldova are: integral management, democratic management and river basin management [38]. The starting point of the scientific study was the analysis of existing studies that are related to the proposed research topic, thus placing this work at the intersection of several scientific directions, which also argued its complexity and importance. Thus, were consulted numerous works from the fields of geography [32-34, 51], ecology [22-25, 36], economics [6, 7, 10-12, 20].

The following methods were used in this work: historical, statistical, deductive, comparative, etc. SWOT analysis also played an important role in highlighting opportunities and risks related to water resources and their management. ArcMap software was used to develop maps on the spatial distribution of groundwater reserves and water abstraction and use indices, which allowed a comparative analysis and the highlighting of differences at district, regional and river basin level. The information base comprised a range of statistical data from 2003 to 2021, which were selected, systematised and thoroughly processed from the annual water management index reports. The main data sources were: 1) Annual Reports of the Moldovan Water Agency [2-4]; 2) Annual Reports of the Environmental Agencies and Inspectorates [39]; 2) Annual Reports of the "Apele Moldovei" Agency [2-4]; 3) Reports of the National Bureau of Statistics [18, 19]; 4) Reports of the State Hydrometeorological Service [57].

In **Chapter 2 "Assessment of water resources of the Republic of Moldova"** are analysed the main aspects of the water resources of the Republic of Moldova, at the level of territorial administrative units (TAU) and river basins.

Surface water resources. The hydrographic network of the Republic of Moldova consists of 4 drainage basins: the Dniester river, which constitutes 57% of the surface; the Prut river, with about 24% of the surface, the Danube and Black Sea tributaries, which constitute 19%. An analysis of the water runoff balance on the territory of the Republic of Moldova in recent years (1977-2020) shows a decreasing trend in the volume of runoff. The years 2011-2020 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. 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 water, which is almost half of the multi-year norm of 12.31 km^3 [57].

The main rivers of the Northern Development Region (DR) are the Prut and the Dniester, which are the eastern and western borders of the region. Within the boundaries of the region, the length of the Dniester River is 194 km, basin area - 6087 km^2, and of the Prut river - 232 km, basin area - 3964 km^2 [21]. Through the Northern DR flow 36 rivers. The Central DR has 57 watercourses stretching over a length of 1955 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 small river basins: Salcia, Cahul, Botna and Cogâlnic. In the Autonomous Territorial Unit (ATU) of Găgăuzia surface resources are limited.

Lakes. At present, there are 4,275 natural lakes and reservoirs in the Republic of Moldova with an area of about 43.1 thousand ha, located and built on their courses and riverbeds [39]. About 57% or 2437 of the lakes are located in the Northern DR. More than ½ (52%) are allocated for *fish farming*, 1660 lakes or 39% are allocated for *general use*. Only 6% are allocated for *irrigation* and only 139 lakes for recreation.

Groundwater resources. Moldova's renewable groundwater reserves are estimated at 3.478 million m^3/day. The total number of approved natural mineral water deposits on the territory of the Republic of Moldova as of 01.01.2020 according to the data of the State Balance of Reserves is 68 deposits [1].

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 country. 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 in the *Central Region* are supplied with water mostly from the Badenian-Sarmatian aquifer complex and the Aluvial-Deluvial aquifer horizon. The Central Region has about 68% of the total groundwater reserves exploited in the country. The largest groundwater reserves are located in the districts of the Dniester HD (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 is supplied from the Aluvial-Deluvial aquifer horizon and the Badenian-Sarmatian aquifer complex. The share of groundwater reserves is only 14.5%. The most important underground water reserves are in Căușeni (57.9 thousand m^3/day) and Ștefan Vodă (51.6 thousand m^3/day). On the territory of the *Transnistrian DR* there are 76 underground water reservoirs from 4 aquifers [40, 43].

In **Chapter 3. „The regional particularities of water resources abstraction" –** includes a comprehensive analysis of water abstraction sources, assessing pumping stations, wells and their operation, wells and springs, and their importance in water supply. The particularities of water abstraction from surface and groundwater sources at regional, district and catchment levels were also analysed and highlighted.

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 National Bureau of Statistics data [18], 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.

Borehole. According to EPI data [39], there are 4970 boreholes in the country, of which only 53% are exploited. About 40-50% of the remaining boreholes are abandoned and remain without legal ownership. Most of the unexploited boreholes are located in the Northern RD, where they constitute 62% of the total number of boreholes.

Wells and springs. In the RM, in 2018, 176.4 thousand wells were monitored by the EPI [39]. In the Northern DR are located 107.3 thousand wells, most wells are concentrated in the Edineț (15 898), Briceni (14 587) and Drochia (12 879) districts. 50.3 thousand wells or 28% of the total number of wells in the Republic are located in the Central Region. Most wells are located in Straseni (6911), Ungheni (6112) and Orhei (5485). 18.7 thousand wells are located in the Southern Region of the country, most of them in Leova (3975), Causeni (6112) and Găgăuzia ATU (3176). In RM, 2966 springs were monitored in 2018 [39], 41.5% and 39% respectively were located in the central and northern region, and in the southern region only 234 springs due to limited groundwater reserves in this region.

Volume of water abstracted in regional profile. According to MWA data [2], during the period analysed (2003-2021), the total volume of water abstracted averaged 849 million m^3, including 719 million m^3 (85%) - from surface sources and 130 million m^3 (15%) - from underground sources. More than 80% (670 million m^3) of the total volume of water abstracted in the Republic comes from enterprises in the Transnistrian Development Region, including the municipality of Bender (Tighina).

Table 3.1. Volume (million m^3**) and share (%) of water abstraction by source and region**

TAU	Average of 2003-2021 years							2020						
	total			surface		underground		total			surface		underground	
	V*	%		V*	%	V*	%	V*	%		V*	%	V*	%
Northen DR	**34,2**	**4,0[1]**	**21[2]**	**14,6**	**43[3]**	**19,6**	**57**	**35,9**	**4,2**	**22**	**18,1**	**50**	**17,8**	**50**
Soroca	9,9	1,2	6,2	8,4	87	1,3	13	14,7	1,7	9,2	13,6	93	1,1	7,5
Central DR	26,7	3,1	17	8,5	32	18,1	68	34,3	4,1	21	14,3	42	20,1	59
Chișinău	80,0	9,4	50	75,2	94	4,0	6,0	70,4	8,3	44	66,7	95	3,5	5,0
Central Region	107	13	67	84,3	78	23,0	22	105	12	65	81,1	78	23,6	22
Souther DR	15,4	1,8	9,6	6,5	42	8,8	58	15,5	1,8	10	6,2	40	9,3	60
Găgăuzia	3,7	0,4	2,3	0,4	10	3,3	90	4,0	0,5	2,5	0	0	4,0	100
Souther Region	19,0	2,2	12	6,9	36	12,2	64	19,5	2,3	12	6,2	32	13,3	68
Dniester RS	**160**	**19**	**100**	**105**	**66**	**54,7**	**34**	**160**	**19**	**100**	**105**	***66***	**54,7**	**34**
Transnistrian DR	**689**	**81**	**100**	**615**	**89**	**75,2**	**11**	**686**	**81**	**100**	**611**	**89**	**75,1**	**11**
Dnestrovsc	555	65	81	553	99,7	1,8	0,3	555	66	81	553	99,7	1,9	0,3
Tiraspol	26,7	3,1	3,9	1,3	5,0	25,4	95	26,7	3,2	3,9	1,3	5,0	25,4	95
Bender	24,1	2,8	3,5	0,45	1,9	23,7	98	24,1	2,9	3,5	0,44	2,0	23,6	98
Râbnița	14,8	1,7	2,1	7,9	53	6,9	47	11,1	1,3	1,6	4,1	37	6,9	63
Total RM	**849**	**100**		**719**	**85**	**130**	**15**	**846**	**100**		**716**	**85**	**130**	**15**

*V = volume. **Data source:** Prepared by the author based on data from MWA Annual Reports [2]

[1] Share (%) of total volume of water abstracted in the RM, 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.

The maximum volume of water in the Transnistrian DR is abstracted at the TEPP (Thermo-Electric Power Plant) in Dnestrovsc (555 million m^3 or 81%), as well as in the cities of Tiraspol (26.7 million m^3), Bender (24.1 million m^3) and Râbnița (15.2 million m^3) (figure 3.1).

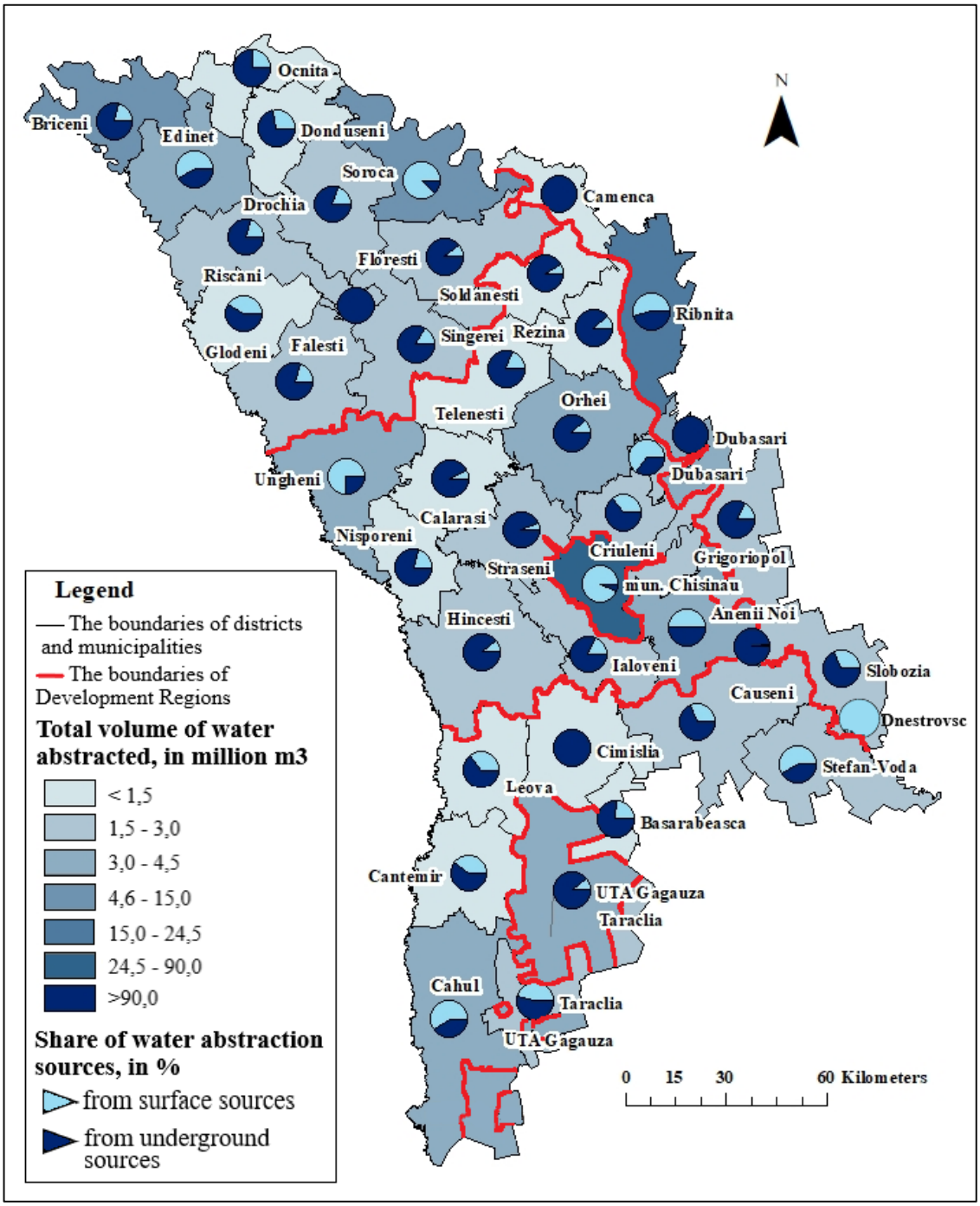

Fig. 3.1 Volume of water abstracted and share of abstraction sources in administrative-territorial units of the Republic of Moldova (average of years 2003-2021)
Data source: Prepared by the author based on data from MWA Annual Reports [2]

On the right side of the Dniester river (RSDR), an average of 160 million m^3 or only 19% of the total volume of water abstracted in the Republic, including in the municipality of Chișinău - 80.0 million m^3 (50%), in the Northern RD - 34.2 million m^3 (21%), in the Central RD - 26.7

million m^3 (17%), Southern Region - 19.1 million m^3 (12%), of which in the Southern RD districts - 15.4 million m^3 (10%) and in ATU Gagauzia - 3.7 million m^3 (2.3%). From surface sources was captured 105 million m^3 or ≈ 2/3 of the total.

At the same time, more than 70% (75.1 million m^3) of the water from surface sources in the RSDR was captured at the Vadul lui Voda station in Chișinău municipality, 14.6 (14%) in the Northern DR, 8.5 million m3 in the Central DR (8%) and 6.9 million m^3 (6%) in the Southern Region. From underground sources, in average, of 54.7 million m3 or more than 1/3 (34%) of the total volume of water abstracted in the RSDR was abstracted. Underground sources predominate in the Central DR with more than 2/3 (68%) of the total volume of water abstracted and in the Southern Region with 66%, including in the Southern DR with 58% and in ATU Găgăuzia with 90% of the total volume of water abstracted.

In the period 2003-2021, the total volume of water abstracted shows an oscillating evolution, marked both by the economic evolution and meteo-climatic peculiarities, and by the evolution of data from the Transnistrian DR. The negative trend is due to the reduction in the volume of water abstracted in the Southern DR (1.5 times) and in Chișinău. At the same time, the volume of water abstracted in the Central DR increased by 30%, due to the faster expansion of rural public aqueducts [18] and the restoration of irrigation systems in the riverine districts of the river. In 2020, 846 million m^3 of water were abstracted, including 686 million m^3 in the Transnistrian DR. On the RSDR were abstracted 160 million m^3, of which 70.4 million m^3 (44%) in the Chisinau municipality, 35.9 million m^3 (22%) in the Northern DR, 34.1 million m^3 (21%) in the Central DR, 15.5 million m^3 (10%) in the Southern DR and 4.0 million m^3 in ATU Găgăuzia (2.5%).

Volume of water abstracted by districts and catchments. The total volume of water abstracted in the Dniester HD is, on average, 816 million m^3 or 96% of the total volume of water abstracted in the Republic. On the right side of the Dniester HD, an average of 126 million m3 or only 15% of the total volume of water abstracted in the Dniester HD and 79% in the RSDR was abstracted. In Răut HB, an average of 17.0 million m^3 (1.9% of the total volume of water abstracted in RM and 11% in RSDR) was abstracted, in Bâc HB - 7.7 million m^3 (0.8 and 4.4%), and in Botna HB - 2.3 million m^3 or 1.7% of the water abstracted in RSDR. Within the Danube-Prut-Black Sea Hydrographic District (DPBS HD), an average of 33.8 million m^3 of water was abstracted, of which 23.1 million m^3 (68%) from Prut HB and 10.7 million m^3 (32%) from the Danube-Black Sea Hydrographic Space (DBS HS). Compared to Dniester HD, DPBS HD accounts for only 4.0% of the total volume of water abstracted in RM and 21% - in RSDR. In 2020, the total volume of water abstracted in Dniester HD was 812 million m^3. In DPBS HD, the total volume of abstracted waters was 34.2 million m^3, including 22.3 million m^3 (65%) from HB Prut and 11.9 million m^3 (35%) - in DBS HS.

In **Chapter 4. „Regional and branch peculiarities of water resources use"** were analysed the spatial and branch aspects of water resources consumption, identifying the sectors, branches and economic activities with massive water consumption. Trends in the volume of water used at regional, district, district and catchment levels were analysed. The status and dynamics of public water supply systems were analysed.

Volume of water used in total and by use categories. During the period under review, the total volume of water used in the Republic of Moldova averaged 785 million m^3, of which 670 million m^3 (85%) in the Transnistrian DR.

Table 4.1. Volume (million m^3**) and share (%) of water use by regions and use categories (average of years 2003-2021)**

UAT	total			household		technological		agriculture					
								total		regular irrigation		others	
	V*	%	%	V*	%	V*	%	V*	%	V*	%	V*	%
Northen DR	24,3	3,1	21	6,6	27	3,4	14	14,2	59	4,0	16	10,2	42
Bălți	5,1	0,6	4,4	3,4	67	1,6	31	0,17	3,3	0	0	0,16	3,1
Central DR	24,6	3,1	21	4,7	19	1,3	5,1	18,4	75	5,5	22	12,9	52
Chișinău	50,4	6,4	44	41,4	82	8,4	17	0,56	1,1	0,2	0,5	0,33	0,7
Central Region	75,0	9,6	65	46,2	62	9,6	13	18,9	25	5,7	7,6	13,2	18
Souther DR	13,6	1,7	12	2,8	21	0,65	4,8	9,9	73	3,3	25	6,6	48
Găgăuzia	2,6	0,3	2,3	0,9	35	0,12	4,8	1,4	53	0,2	9,1	1,1	44
Souther Region	16,1	2,1	14	3,7	23	0,77	5,5	11,3	70	3,6	22	7,7	48
Dniester RS	**115**	**15**	**100**	**56,5**	**49**	**13,8**	**12**	**44,4**	**38**	**13,3**	**11**	**31,2**	**27**
Transnistrian DR	**670**	**85**	**100**	**60,0**	**9,0**	**568**	**85**	**39,6**	**5,9**	**32,8**	**4,9**	**6,8**	**1,0**
Dnestrovsc	555	71	83	2,7	0,5	553	99,7	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	7,8	0,04	0	0,03	0	0	0
Râbnița	13,5	1,7	2,0	10,8	80	3,0	22	0	0	0	0	0	0
Total RM	**785**	**100**		**116**	**15**	**582**	**74**	**84,0**	**11**	**46,1**	**5,9**	**37,9**	**4,8**

*V = volume. **Data source:** Prepared by the author based on data from MWA Annual Reports [2]

116 million m^3 or only 15% of the total volume was used in the RSDR, including 50.4 million m^3 (44%) in the Chisinau, 24.6 million m^3 (12%) in the Central DR, 24.3 million m^3 (12%) in the Northern DR and 1.5 million m^3 (12%) in the Northern DR 24,3 million m^3 (21%), Southern Region - 16.2 million m^3 (14%) (table 4.1).

If we take into account the Transnistrian DR, then ≈¾ (582 million m^3) of the total volume of water used in the Republic of Molfova is used for technological purposes, 15% or 116 million $m^3$for domestic purposes, and only 11% or 84 million m^3 is used in agriculture, of which 46.1 million m^3 (6%) for regular irrigation.

Outside the Transnistrian DR, on average, 44.4 million m^3 of water or 38% of the total volume was used for agricultural purposes, including 13.3 million m^3 (11%) for irrigation and 13.8 million m^3 (12%) for industrial purposes. At the same time, in most of the districts of the right side of the Dniester river more than ¾ of the total volume was used for agricultural purposes (Figure 4.1).

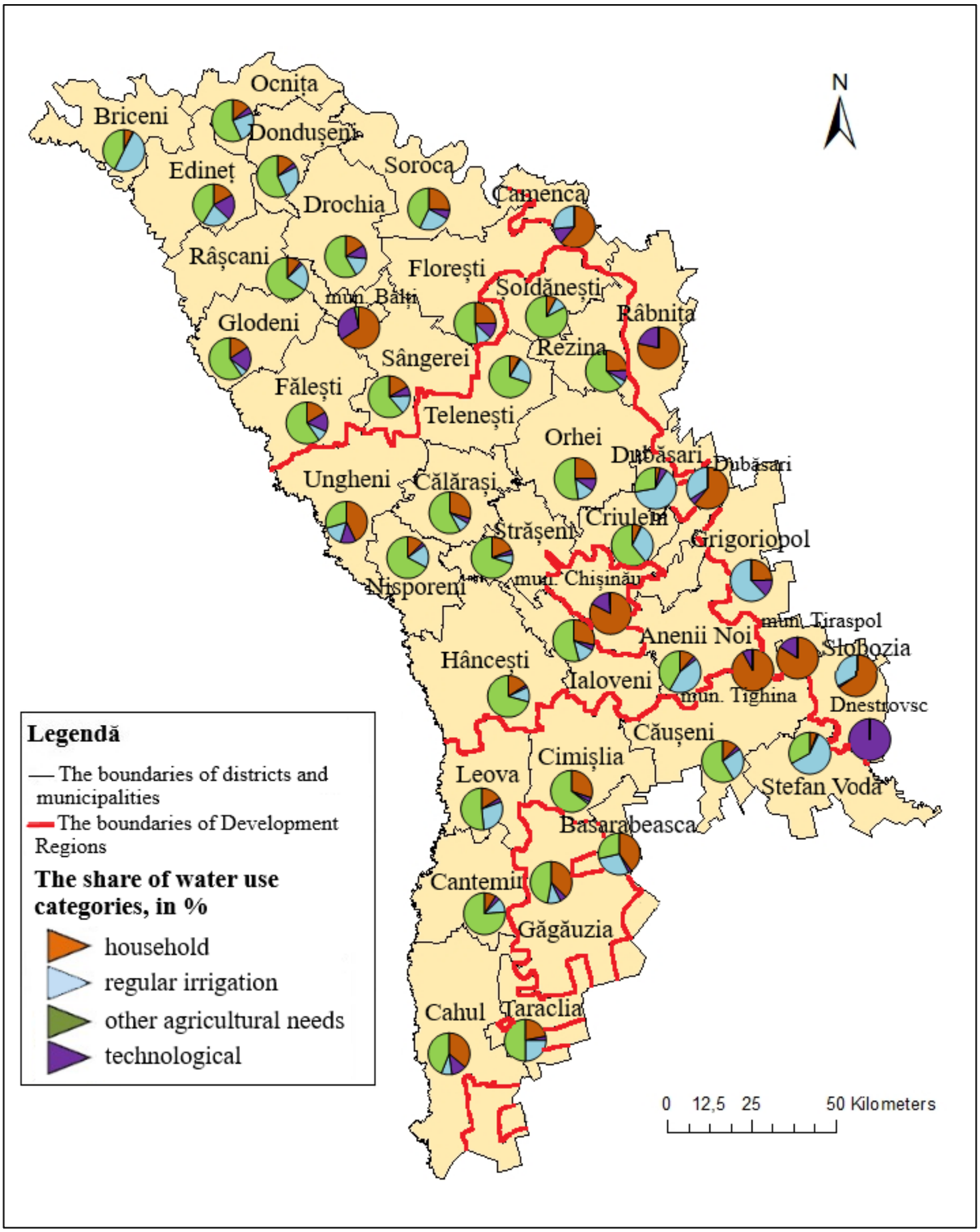

Fig. 4.1 Share of water use categories in administrative-territorial units of the Republic of Moldova (average of years 2003-2021)

Source: Figures 4.1, 4.2 were compiled by the author based on data from the MWA Reports [2].

Dynamics of the volume of water used. In the years 2003-2021, similar to the abstracted water, the total volume of water used shows an oscillating evolution, caused by the annual trend of atmospheric precipitation and economic development, as well as by data from the Transnistrian DR. In the years 2003-2006, a reduction is observed in the RSDR, which is manifested in the

Southern DR, Central DR and Northern DR in the volume of water used for agricultural and technological purposes, due to the decommissioning of state irrigation systems [6], bankruptcy and reduction of industrial production, etc. In the years 2015-2021, the volume of water used shows a weak but positive oscillating trend, except for the Central DR, which records a significant increase (by 35%) in the volume of water used, caused by increased demand and massive consumption of water in irrigation in 2020.

In 2020, the total volume of water used in the RM was 787 million m^3. In the Transnistrian DR, 668 million m^3 were used, which is 85% of the total per Republic (Table 4.2). 119 million m^3 were used in the right side of the Dniester, of which 46.7 million m3 (39%) - in the Chisinau, 32.7 million m^3 (28%) - in the Central DR, 23.9 million m^3 (20%) - in the Northern DR, 13.2 million m^3 (11%) - in the Southern DR and 2.7 million m^3 (2%) - in ATU Gagauzia..

Volume of water used by hydrographyc districts and basins. According to MWA data, the total volume of water used in the Dniester HD averaged 759 million m^3 or 97% of the total volume of water used in the country. In Răut HB, 14.7 million m^3were used, which is ≈13% of the total volume of water used in the right side of the Dniester HD, including from the Răut riverbed - 5.0 million m^3 (4.3%). In Bâc HB (without Chișinău) 6.4 million m^3 (5.6%) of water were used, and in Botna HB - 2.2 million m^3 or 1.9% of the water used in the Dniester HD.

Table 4.1. Volume (million m^3**) and share (%) of water use by regions and use categories by hydrographyc districts and basins (average of years 2003-2021)**

Hydrographyc basins	total			household		technological		agriculture					
								total		regular irrigation		others	
	V*	%	%	V*	%	V*	%	V*	%	V*	%	V*	%
Dniester HD	**759**	**97**	**77[4]**	**110**	**15**	**580**	**76**	**66,2**	**8,7**	**41,0**	**5,4**	**25,1**	**3,3**
Dniester riverbed	163	21		100	61	21,7	13	40,9	25	35,1	22	5,7	3,5
Răut	14,7	1,9	13	3,0	20	1,8	12	10,0	68	1,9	13	8,1	55
Răut riverbed	5,0	0,6	4,3	1,9	38	1,2	24	2,0	40	0,5	10	1,5	30
Bâc	6,4	0,8	5,6	2,5	38	1,7	19	2,8	44	0,2	3,7	2,6	41
Botna	2,2	0,3	1,9	0,3	14	0,1	5	1,7	80	0,4	16	1,4	63
Prut	**17,3**	**2,2**	**15**	**3,8**	**22**	**1,7**	**10**	**11,7**	**67**	**3,6**	21	**8,1**	**47**
Prut riverbed	6,8	0,9	5,9	3,0	44	1,1	16	2,7	39	1,2	18	1,5	22
Ialpug	4,2	0,5	3,6	1,0	24	0,1	3,6	2,8	67	0,4	9,2	2,4	58
Cahul	0,8	0,1	0,7	0,13	17	0,03	4,2	0,5	57	0,2	26	0,3	36
Cogâlnic	2,6	0,3	2,3	0,9	34	0,07	2,7	1,7	63	0,3	12	1,3	51
Kitai	0,3	0,04	0,3	0,06	19	0,02	5,1	0,24	75	0,1	21	0,2	59
Sărata	0,5	0,06	0,4	0,13	25	0,01	2,4	0,4	72	0,1	12	0,3	60
Hadjider	0,5	0,07	0,5	0,03	0	0,04	0,0	0,5	97	0,3	63	0,2	34
DBS HS	**8,9**	**1,1**	**7,7**	**2,2**	**25**	**0,3**	**3,1**	**6,0**	**67**	**1,3**	**15**	**4,7**	**52**
DBBS HD	**26,3**	**3,3**	**23**	**6,1**	**23**	**2,0**	**7,6**	**17,7**	**67**	**4,9**	**19**	**12,8**	**49**

*V = volume. **Data source:** Prepared by the author based on data from MWA Annual Reports [2]

The total volume of water used in DH DPMN on average was only 26.3 million m^3 or only 2.2% of the total volume of water used in the RM and 23% - in RSDR. DPBS HD has a major

[4] Share on the right side of the Dniester

contribution to the water supply in the west and south of RM. In Prut HB, an average of 17.3 million m^3 of water was used, which represents only 15% of the total volume of water used in the right side of the Dniester river and 2/3 (66%) of the DPBS HD. The total volume of water used in DSB HS was on average 8.9 million m^3 or only 7.7% of the total volume of water used in RSDR and 34% of DPBS HD, including 4.2 million m^3 (16%) in Ialpug HB, 2.6 million m^3 (10%) in Cogâlnic HB, 791 thousand m^3 in Cahul HB, 547 thousand m^3 in Hadjider HB, 498 thousand m^3 in Sărata HB and 309 thousand m^3 in Kitai HB.

Public water supply systems. In the years 2007-2021, the number of public water supply systems in the RM increased by about 2.4 times or from 564 units to 1365 units, of which more than 90% of systems are operational. In rural areas they increased by 2.7 times (from 475 to 1301) and in urban areas they decreased by 1.3 times. The largest increase is in the Central DR (3.1 times) and Northern DR (2.7 times), as well as in 2014-2016, as a result of the successful start of the implementation of the Water Supply and Sanitation Strategy [47]. In 2021, were registered 1365 systems: 633 (46%) - in Central DR, 335 (25%) - in Southern DR and Northern DR, 41 (3.0%) - in ATU Gagauzia and 21 (1.5%) - in Chișinău.

The total length of public aqueducts increased in 2007-2021 by 2.3 times, including 8.7 thousand km in rural areas and 657 km in urban areas. In the Central DR, the length of aqueducts increased by 3.7 times (by 4.2 thousand km), in the Northern DR - by 2.6 times (by 2.5 thousand km), in the Southern DR - by 2.4 times (by 2.1 thousand km), in ATU Gagauzia - by 1.6 times (by 363 km) and in mun. Chisinau - by 15% (264 km). Currently about 2.2 million people or 2/3 (67%) of the total population in the Republic of Moldova (excluding the Transnistrian DR) have access to public water supply systems (1.3 million people or 93% - from urban areas and 950 thousand people or ≈50% - from rural areas). Despite the rapid expansion of water supply networks, per capita water consumption is relatively low at 115 l/day, including 153 l/day in urban areas and only 65 l/day in rural areas, or more than 2 times less than the population water consumption norm.

In **Chapter 5. „Water resources management"** was analysed the information system of water resources use and management, and the main aspects of the water resources information system and monitoring were highlighted. In addition, the current water resources management mechanism and its main tools are assessed.

Information support for water resources management. The Water Resources Information System (WRIS) is a system that provides a modern framework for data exchange between state institutions and public access to this information. The institutions that are part of the WRIS are: the Ministry of Environment and the Ministry of Health, including their subordinate

institutions [54]. Currently, the WRIS is in the process of being completed, and the institutions that are part of this system have not yet fully engaged in supporting it, largely due to the reorganisation processes that are currently taking place.

Legal and institutional framework of water resources management in the Republic of Moldova. *The normative-legislative* framework for the use and management of water resources is stipulated in*:* Water Law No. 272 of 23.12.2011 [45]; Law no. 272- XIV of 10.02.1999 on drinking water; Law no. 1102 of 06.02.1997 on natural resources; Law on zones and strips of protection of rivers and water basins; Law no. 303 of 13.12.2013 on public water supply and sanitation; Government Decision no. 199 of 20.03.2014 on the approval of the Water Supply and Sanitation Strategy (2014 - 2028), et all. *The institutional framework* for water resources management consists of: Parliament of the Republic of Moldova (legislative authority for adopting legislative acts); Government of the Republic of Moldova (implementation of state policy); Ministry of Environment (implementation of state policy in the field of water resources management); Environmental Agency (implementation of state policy in the fields of water pollution prevention, protection and regulation of water resources use); Inspectorate for Environmental Protection (control over the compliance of water resources use and their protection areas); Water Agency of Moldova (water and land management of the water fund); Agency for Geology and Mineral Resources (design of boreholes and groundwater intakes).

Water resources monitoring

Surface water monitoring. Spatial dispersion of surface water hydrological monitoring points is uneven, with 20 located in DPBS HD and 32 in Dniester HD. There are 17 hydrological observation points located in the Northern DR, 10 of which are located in Prut HB. Within the boundaries of the Northern DR, rivers are subject to monitoring: Prut, Vilia, Racovăț, Căldărușa, Dniester, Răut, Căinari, Ciuhur, Draghiște and Cubolta. In the Central Region there are 8 hydrological monitoring observation points, one of which is at the lake. The flow and level of the Prut, Răut, Bâc, Cogâlnic, Ichel, Ciorna, Delia and Ciulucul Mic rivers are monitored in the region. In the Southern Region, are located 12 hydrological stations monitoring the flows and levels of the Dniester, Prut, Botna, Cogâlnic, Ialpug, Lunga and Salcia rivers. In the Transnistrian DR 13 stations are located.

Groundwater monitoring. The groundwater monitoring network in the RM consists of 177 points. Most monitoring points (94) are located in the Badenian-Sarmatian aquifer complex, due to the fact that it is spread almost all over the territory and is the main source of groundwater supply to the Republic of Moldova. The Holocene alluvial-deluvial aquifer is monitored by 36

monitoring wells. The Silurian-Cretaceous aquifer complex is monitored by 20 wells, 15 of which are located in Northern DR and 5 in Central DR, including one in Chisinau. The Pontian aquifer horizon is monitored by 6 wells, 4 of which are in ATU Gagauzia. Due to the small size of the Vendian-Rifeic aquifer horizon, there is only one monitoring point in the Vendian-Rifeic aquifer in the locality of Calarasovca, Ocnitsa r. Although the waters of the Pliocene-Pleistocene aquifer complex are used by the population, there are no monitoring wells in the complex. That is why it is important to place monitoring wells in this aquifer, especially since the water of this aquifer is quite chemically loaded but is used by the population anyway.

Economic mechanism of water resources management in RM

Subsidies to finance the rational use and protection of water resources. Most of the projects and amounts allocated from the National Ecological Fund (NEF) have benefited the regions of Sangerei, Falesti and Rascani in the Northern DR, Orhei, Hincesti, Ungheni and Ialoveni in the Central DR, Causeni, Cantemir and Leova in the Southern DR. In 2007-2009, the number of projects approved by the NEF decreased 1.8 times. In the years 2008-2014, there was a 3.6-fold increase in the number of projects and a 12.6-fold increase in the amount of water-related grants. In the years 2020-2021, the number and amount of approved projects have come close to those of 2016, but the situation has not significantly improved due to the COVID-19 pandemic and the severe drought in 2020.

Taxes for the use of water resources. The amount of the water consumption charge depends on weather conditions, water consumption and the amount of the mineral water extraction charge. In this context, in 2008, following the doubling of the mineral water abstraction tax rate and the extension of the scope of application, there was a considerable increase in revenue. The highest revenue is recorded in the districts with the highest water consumption, such as Rascani, Criuleni, Anenii Noi and Cahul, Floresti, Soroca, Edinet, Orhei, Ungheni, ATU Gagauzia. The average amount of payments for wastewater discharge was 5.7 million lei. In the Northern RD, the average amount of these payments is 1.8 million lei (31%), in the Central RD - 1.1 million lei (19%), in mun. Chisinau - 1.8 million lei (32%), in the Southern RD - 746 thousand lei (13%) and in ATU Gagauzia - 246 thousand lei. In 2020, the amount of the respective payments was 7.3 million lei, including in the Northern DR - 21%, in the Central DR - 15%, in Chisinau 42%, in the South DR - 12% and in ATU Gagauzia 10%. In 2021, the amount of payments for discharges of wastewater pollutants was 10.3 million lei or 3.0 million lei more than in 2020 with severe pandemic restrictions and drought.

Fines for violating water use and protection legislation. The maximum number of fines was recorded in 2004 and 2008, and the minimum in 2003 and 2006, due not so much to the frequency

of checks as to the administrative changes of the districts (2003) and territorial environmental authorities (2006). The minimum in 2009 (658 fines) can be explained by the slower application of the provisions of the new Contravention Code. The amount of fines increased by ≈18 times. In 2020, a total of 1070 fines were imposed for violation of water use and protection legislation, amounting to ≈ 2.4 million lei. The amount of fines collected in 2020 for water contraventions was 919 thousand lei or 39% of the amount of fines imposed [19].

Prejudices cause to water resources. During the period under review, the most frequent and maximum amounts of water damage were applied in Chisinau. In 2019 alone, actions for recovery of water damage amounting to 41.0 million lei were applied in Chisinau, but were not paid. Also, at a great distance, the Dondușeni Fălești, Anenii Noi, Strășeni, Orhei, Ungheni, Cimișlia and Taraclia districts stand out. In 2020, the amount of actions calculated for water damage amounted to 4.3 million lei, including 4.0 million lei in the district of Straseni , which also have not been paid, 40 thousand lei in Cimislia, of which only 16.5 thousand lei have been collected, 36.3 thousand lei in the district of Dubasari, 21.9 thousand lei in the district of Cantemir, paid in full in both districts.

General conclusions

1. The review of research in the field of water resources management revealed a low number of studies on the complex assessment of water resources from an economic-geographical point of view. There is a scarcity of research on small and medium-sized rivers, with transboundary rivers being studied more due to the greater financial assistance for this from the EU and partnerships with neighbouring countries in the management of these rivers.

2. The main surface water resources, as well as groundwater resources, are located in the Dniester HD, where the density of hydrographic networks is higher than in the DPBS HD. The most significant surface water resources are available in the districts along the Dniester and Prut rivers, and the most significant groundwater resources are available in the districts along the Dniester river in the Central DR. The groundwater of the Badenian-Sarmatian aquifer complex is more frequently used, due to its distribution throughout the Republic and better water quality, as well as the more available waters of the Alluvial-Deluvial aquifer horizon.

3. Due to reduced access to public water supplies, non-centralised sources (lakes, wells and springs) have an important role in water supply, especially in rural areas. Despite the fact that 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.

4. Separate analysis of the volumes of water abstracted and used on the right and left side of the Dniester, Chișinău and Bălți municipalities, is very important when assessing and

forecasting the total and sectoral demand for water, under the various scenarios of operation of the Dniester Hydro Power Complex and accelerating climate change.

5. The volumes of water abstracted and used shall be determined by the available water resources and the demand for water, as well as the capacities for abstraction, transport and use of water. More than 80% (670 million m^3) of the total volume of water abstracted in the Republic comes from sources in the Transnistrian DR. In the right side of the Dniester about ½ (80 million m^3) of the water is abstracted in the 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 HPC, and only 20% (144 million m^3) - from the Dniester riverbed. At the same time, the majority of settlements on both banks of the Dniester are supplied from underground sources.

6. 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 attributed to technological purposes. About 15% or 117 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. In the right side of dniester river, domestic uses prevail in the Chișinău (82%) and Bălți (66%), and in the districts - agricultural uses.

7. In the years 2003-2021, the total volume of water abstracted and used shows an oscillating evolution, on the basis of a general negative trend, which is more pronounced for water abstracted from surface sources and used for domestic purposes in the municipality of Chisinau and for agricultural purposes - in the Southern Region. In the years 2007 and 2020, as a result of severe droughts, there is a maximum consumption of water. In the years 2015-2020, there is a positive dynamic, which is due to the significant expansion of rural public aqueducts, partial restoration of irrigation systems, and an increase in metered water consumption.

8. As a result of the rapid expansion of the public water supply network, 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.

9. The Republic of Moldova has an adequate legal framework for the efficient management of water resources, and the competences of public authorities in this field and the requirements for users are well defined and oriented towards sustainable water resources development. Despite these achievements, due to the permanent reorganisation of the institutions in the field, the definitive role of each institution in managing and ensuring the sustainability of water resources is not clear.

10. Following the analysis of the surface water monitoring network, it was found that most of the hydrological stations are located in the Dniester DHD, thus resulting in a situation where small and medium-sized rivers, especially in the Danube-Prut Black Sea HD are insufficiently monitored. The evaluation of the groundwater monitoring network revealed a low number or lack of monitoring wells in some aquifer horizons, as well as in the Bălți municipality with important groundwater deposits, but without monitoring points.

11. Economic instruments for managing water resources and their anthropic impact on them do not provide the necessary motivation for users and polluters to reduce water consumption and pollution of aquatic objectives. Despite the presence of an adequate damage assessment methodology, due to the acute shortage of approved technical equipment and accredited personnel, most water damage is not assessed and compensated and only fines are imposed on offenders.

General recommendations

1. Elaboration of updated studies on water use and Management Plans of small and medium-sized river basins, their integration into the Management Plans and Programs of Measures of the Dniester HD and DPBS HD.

2. Due to the high share of unused boreholes, it is necessary to create a Regulation on the location of new boreholes, based on natural, social and techno-economic criteria, and to properly preserve the unused ones. In addition, in order to avoid negative impacts on the health of the population, permanent sanitary and ecological monitoring of wells, springs and lakes is necessary.

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

4. An important aspect in the correct and efficient management of water resources is the extension of public water supply systems, especially in rural areas of the Northern and Central RD, in order to ensure planned access of the population to quality water, but also for the metered recording of the consumption of water resources.

5. Creation and adequate management of the Water Resources Integrated Information System (WRIIS) to eliminate discrepancies between different sources and databases. For this purpose, it is imperative that the public authorities responsible for water resources management in Chisinau and Tiraspol create a common platform for the completion of the WRIIS, coordination

and implementation of measures in the field of sustainable water resources development and management.

6. Extend the national networks for hydrological and quality monitoring of surface waters to include medium and medium-sized rivers such as Botna and Căinari. It is also necessary to locate groundwater monitoring points in the Pliocene-Pleistocene aquifer complex and in areas with rich groundwater reserves where monitoring wells are lacking (Bălți municipality).

7. Increase funding to the rural water supply sector in the Northern and Central DR for more uniform coverage of the country with water supply networks and to ensure access to quality water services for the population. In addition, in order to ensure sustainable use of water resources, the planning process for the extension/construction of water supply networks should also include parallel planning of sewerage systems to avoid uncontrolled wastewater discharge.

8. It is necessary to adjust the rates of charges for water use and pollution, as well as water damage to the inflation rate, to the costs of maintenance and restoration of water sources, the degree of water supply to the territory, the ecological and sanitary-hygienic condition of water objects, the public expenses of assessment, monitoring and administration of water resources. It is imperative to increase the approved technical capacities and certified personnel for the assessment of damage caused to water resources, the appropriate filing of recovery actions and the avoidance of disputes on compensation for such damage.

Selective bibliography

1. Academia de Științe a Moldovei. Rezumatul Proiectului: *Condiţiile de formare şi estimarea regională a resurselor naturale ale apelor subterane (studiu de caz Republica Moldova)*. Chișinău, 2015. [citat 12.11.2017], Disponibil: https://old.asm.md/administrator/fisiere/activitati/f2774.pdf.
2. Agenţia Apele Moldovei. Rapoartele anuale (2003-2021) generalizate „Utilizarea apelor în Republica Moldova". Preprint.
3. Agenția Apele Moldovei. Rapoartele anuale (1988-1992; 2001-2019) generalizate ale Stațiilor Tehnologice de Irigare (Sistemelor Centralizate de Irigare). Preprint.
4. Agenția Apele Moldovei. Rapoartele anuale (2013-2019) generalizate ale Asociațiilor Utilizatorilor de Apă. Preprint.
5. Asociaţia „Moldova Apă-Canal". Indicii financiari şi de producţie ai activităţii întreprinderilor de alimentare cu apă şi canalizare. În: www.amac.md
6. BACAL, P. *Economia protecţiei mediului:* Note de curs. Chișinău: ASEM, 2007. 414 p. ISBN 978-9975-75-214-5
7. BACAL, P. *Economic and geographical aspects of water use in the Prut river basin (The sector of the Republic of Moldova*). In: Present Environment and Sustainable Development, Volume 10, no. 2, 2016, pp. 77-94.
8. BACAL, P. *Gestiunea protecţiei mediului înconjurător în Republica Moldova (Aspecte teoretice şi aplicative)*. Chişinău: ASEM, 2010. 240 p. ISBN 978-9975-75-536-8
9. BACAL, P. *Geographic and economic aspects of using water resources in the Dniester basin (The sector of the Republic of Moldova*). În: Journal of Settlement and Spacial Planning, Special Issue No. 3/2014. Cluj: Presa Universitară Clujeană, 2014. p. 101-111
10. BACAL, P. *Mecanismul economic de protecție a mediului în Republica Moldova. Abordare geografică și ecologică*. Chișinău: Biotehdesign, 2018. 296 p. ISBN 978-9975-108-50-8.
11. BACAL, P. *Reglementarea economică a impactului apelor reziduale în Regiunea de Dezvoltare Centru a Republicii Moldova*. În: Economica, nr. 2 (100), 2017, pp. 68-82. Ed. ASEM, Chișinău, 2017.
12. BACAL, P. *Taxele pentru utilizarea resurselor de apă în Republica Moldova. Problemele şi direcţiile reformării lor*. În*:* Economica, nr. 2, 2015. p. 43-50. Ed. ASEM Chișinău, 2015. ISSN 1810-9136.
13. BACAL, P., **BURDUJA, D.** *Dynamics and branch structure of water consumption in the Republic of Moldova*. In: Present Environment and Sustainable Development. Vol 11, no. 2, 2017. p. 187-201. ISNN 1843-5971, e-ISSN: 2284-7820.
14. BACAL, P., **BURDUJA, D.** *Realizări și probleme în reformarea cadrului legal și instituțional în domeniul gestionării resurselor de apă ale Republicii Moldova*. Conferința "Reglementarea utilizării resurselor naturale: realizări și perspective". 2022. pp. 502-505. ISBN: 978-9975-64-271-2; 978-9975-64-328-3
15. BĂLOIU, V. *Gospodărirea apelor*. Editura: Didactică şi Pedagogică, Bucureşti. 1971.
16. BEJENARU, Gh, MELNICIUC, O. *Resursele de apă ale Republicii Moldova* (teoria formării și sinteze regionale). Chișinău. 2020, 338 p. ISBN 978-9975-3448-1-4.
17. BEJENARU, Gh., CASTRAVEȚ, T., DILAN, V. *Calcule Hidrologice*. Ministerul Agriculturii, Dezvoltării Regionale și Mediului, Proiectul „Consolidarea cadrului instituțional în

sectorul alimentării cu apă și sanitație din Moldova". – Chișinău Ș S.n., 2020 (Tipogr. „Print-Caro"). – 178p. ISBN 978-9975-56-770-1
18. Biroul Național de Statistică. Statistici pe domenii. *Statistica Socială*. *Locuințe și utilități publice. Sisteme publice de alimentare cu apă și de canalizare*. În: http//www.statistica.gov. md.
19. Biroul Național de Statistică. Rapoartele statistice privind aplicarea sancțiunilor contravenționale. Anii 2003-2020. Preprint.
20. BUDEANSCHI, D., CIULUC, E., LUPUŞOR, A. *Investigarea transparenţei şi eficienţei economice a utilizării fondurilor ecologice în RM*. Chişinău, 2011. 80 p.
21. BULIMAGA, C., BACAL, P. *Studiul Diagnostic al ecosistemelor urbane și rurale din Regiunea de Dezvoltare Nord a Republicii Moldova*. Chișinău: Tipografia "Impressum". 2020. 124 p.
22. CAPCELEA, A. *Managementul ecologic. Fundamentarea teoretică și evoluția paradigmelor*. Chișinău: Știința, 2003. 192 p. ISBN 978-9975-67-835-3.
23. CAPCELEA, A. *Sistemul managementul ecologic*. Chișinău: Știința, 2003. 259 p. ISBN 978-9975-67-879-7
24. CAPCELEA, A. *Managementul ecologic la diferite niveluri. Particularitățile funcționării și căile de armonizare.* Chișinău: Știința, 2003. 320 p. ISBN 978-9975-67-878
25. CAZAC, V., MIHĂILESCU, C., BEJENARU, GH. *Resursele acvatice ale Republicii Moldova. Apele de suprafață*. Chișinău, Ed. Știința. 2010. 248 p.
26. CHIRICĂ, L., COADĂ, D. *Unele aspecte hidrogeologice ale apelor subterane din municipiul Chişinău*. [citat 09.12.2021]. Disponibil:https://ibn.idsi.md/sites/default/files/imag_file/Unele%20aspecte%20hidrogeologice%20ale%20apelor%20subterane%2013_18.pdf
27. CONSTANTIN, E., MĂRĂCINEANU, F., et al. *Strategia globală a gospodăririi resurselor de apă.* Agricultura – Ştiinţă şi practică. 2009, pp. 106 – 111. [citat 17.05.2018]. Disponibil: http://journals.usamvcluj.ro/index.php/agricultura/article/viewFile/3518/3229
28. CREŢU, Gh. *Optimizarea sistemelor de gospodărirea apelor*. 1980. Ed. Facla, Timişoara.
29. DRAGOMAN, S. *Raport privind analiza situaţiei în sectorul resurselor de apă în contextul adaptărilor la schimbările climatice*. 2012, 53p. [citat 13 Aprilie 2018]. Disponibil: http://adapt.clima.md/public/publications/3655279_md_raport_final_s.pdf
30. DROBOT, R., ŞERBAN, P. *Aplicaţii de hidrologie şi gospodărirea apelor,* Editura HGA, Bucureşti. 1999.
31. EFROS, V. *Dicţionar de geografie economică şi umană.* Editura Universităţii Suceava.2002, 231 pag. ISBN 973-8293-47-2
32. EFROS, V. *Geografia economiei mondiale*. Editura Universităţii Suceava. 2004, 352 pag. ISBN 973-666-126-1
33. EFROS, V., BACAL, P, BOLOCAN, D. *Geografia economică şi socială mondială.* Vol. II, Editura Evrica, Chişinău. Capitolul XIII – Geografia turismului, 2004. pp. 446-484. ISBN 9975-942-48-2
34. Fondul Ecologic Național. Listele proiectelor aprobate pentru finanţare din Fondul Ecologic Naţional în anii 2010-2020.
35. GĂLIE, A. *Impactul schimbărilor climatice asupra resurselor de apă şi a sistemelor de gospodărirea apelor*. Editura Tipored, 2006, Bucureşti.

36. HG nr. 491 din 23.10.2019 cu privire la aprobarea *Conceptului Sistemului informațional automatizat „Cadastrul de stat al apelor”*. În: Monitorul Oficial nr. 346-351 din 22.11.2019
37. Hotărârea Parlamentului Republicii Moldova nr. 325 din 18.07.2003 privind aprobarea Concepţiei politicii naţionale în domeniul resurselor de apă**.** *Monitorul Oficial.* 2003, nr. 191, art nr: 761.
38. Inspectoratul pentru Protecția Mediului. Anuarele (2018-2020). Protecția Mediului în Republica Moldova. Chișinău: Ed. Pontos.
39. IURCIUC, B. *Apele subterane.* Raport. Agenția pentru Geologie și Resurse Minerale. 2017. [citat 03.03.2022]. Disponibil: https://dniester-commission.com/wp-content/uploads/2018/07/geology_Moldova_Iurciuc.pdf.
40. JELEAPOV, A. *Resursele de apă ale râurilor din cadrul Regiunii de Dezvoltare Nord a Republicii Moldova*. În: Buletinul Academiei de Ştiinţe a Moldovei. Științele vieții. Numărul 1(345) / 2022, pp. 109-117. ISSN 1857-064X
41. Întreprinderea de Stat „Expediţia Hidro-Geologică din Moldova”. *Monitorizarea apelor subterane*. [citat 20.10.2018]. Disponibil: http://www.ehgeom.gov.md/ro/proiecte-din-bugetul-de-stat/monitorizarea-apelor-subterane
42. JOHNSON, L. E. *Geographic information systems in water resources engineering*. CRC Press 2008. 328 p. ISBN 9781420069136
43. Legea apelor nr. 272 din 23.12.2011. În: *Monitorul Oficial al Republicii Moldova* nr. 81din 26.04.2012.
44. MELNICIUC, O., JELEAPOV, A., ET AL. *Resursele minime admisibile de apă ale Republicii Moldova*. Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţele vieţii Numărul 3(339). 2019, pp. 135-144. ISSN 1857-064X
45. Ministerul Agriculturii, Dezvoltării Regionale și Mediului. *Rapoartele privind implementarea Strategiei de alimentare cu apă și sanitație (2014-2028) în anii 2017-2020.* În: https://cancelaria.gov.md/sites/default/files/document/attachments/proiectul_450.pdf
46. MORARU, C. *Apele subterane industriale ale Republicii Moldova*. [citat 11.05.2021]. Disponibil:
https://ibn.idsi.md/sites/default/files/imag_file/Apele%20subterane%20industriale.pdf
47. MORARU, C. *Ground water quality in the Republic of Moldova*. In: Management of water quality in Moldova. Springer, 2014, pp.177-197.ISSN 0921-092X. MORARU, C. *Rezervele exploatabile ale apelor subterane din Republica Moldova.* În: „Akademos”, Nr. 2 (49). Chișinău, 2018. pp. 34-41. ISSN 1857-0461
48. MUNTELE, I., IAȚU, C. *Geografia Economică*. Iași. Ed. Economica, 280 p. ISBN 9735906511
49. UNGUREANU, I., MUNTELE, I., DRAGU, V., GHEORGHIȚĂ, GH. *Geografia mediului: omul şi natura la început de mileniu.* 2003. 124. p. ISBN 9736112477
50. National Research Council. *Estimating Water Use in the United States: A New Paradigm for the National Water-Use Information Program (2002).* National Academies Press. Washington, 2004. 190 p. ISBN 978-0-309-08483-3
51. Portalul Informațional al Resurselor de apă (SIRA). [citat 19.06.2022]. Dispobibil: http://www.sira.brand.md/pageview.php?l=ro&idc=151&t=/Despre-portal/Informatii-generale
52. RĂILEANU, Gh., PRODANOV, D., HRISTOV, N. *Documentația (studiu) de impact asupra mediului pentru reabilitarea funcțiilor zonei umede în lunca râului Cogâlnic, prin construcția*

lacului de acumulare. [citat 03.11.2022]. Disponibil: http://cimislia.md/upload/Documenta%C8%9Bia%20Iazul%20lui%20Iepure.%20Evaluarea%20Impactului%20Asupra%20Mediului.%203.0_compressed.pdf
53. SANDUŢĂ, T., USTUROI, L. *Mecanismul economic de gestiune a resurselor naturale în Republica Moldova*. Chişinău, 2003. 47 p
54. Serviciul Hidrometeorologic de Stat. *Notă cu privire la starea și evoluția resurselor de apă de suprafață*. [citat 22.08.2021]. Disponibil: http://www.meteo.md/images/uploads/gis/hydro/hydro_description.pdf
55. БАРАНСКИЙ, Н. Н. *Экономическая география, экономическая картография*. Москва: Наука, 1956. 319 с.
56. БЕЛИЧЕНКО, Ю. П. *Рациональное использование водных ресурсов* : Учеб. Пособие Свердловск, 1990, 174 с. ISBN 5-7525-0125-3
57. БЕСЦЕННАЯ, М. , ОРЛОВ, В. *Использование, преобразование и охрана водных ресурсов*. Учебное пособие, Ленинград, 1979. 60 с. УДК 502.7(075.8)
58. БОРОВСКИХ, Б. А. *Планирование природопользования:* Вопросы методологии. Москва: Экономика, 1979. 168с.
59. ГЛУХОВ, В. и др. *Экономические основы экологии: учебное пособие*. Питер, 2003. 384 с. ISBN 5-94723-570-6
60. МЕЛЕШКИНА М.Т. и др. *Экономика и окружающая среда./Взаимодействие и управление*. Москва: Экономика, 1979. 207с.
61. МЕЛЬНИЧУК, О., АРНАУТ, Н. *Об оценке влияния на водные ресурсы бассейна Днестра потерь стока на испарение и безвозвратное водопотребление с каскада водохранилищ*. Materialele Conferinţei internaţionale „Managementul bazinului transfrontalier Nistru în cadru noului acord bazinal". Chişinău: Изд «Эко-Тирас», 2013. p. 249-253.
62. МЕЛЬНИЧУК О.Н., ЛАЛЫКИН Н.В.., ФИЛИППЕНКОВ А.И. *Искусственные водоемы Молдовы. (состояние, использование, гидрологические расчеты).* Кишинев : Штиинца, 1992. 211 с. ISBN 5-376-01368-5
63. МОРАРУ К.Е. , ЗИНЧЕНКО О.Д. *Подземные воды г. Кишинэу*. 2005. Кишинев: Elena V.I. ISBN-9975-9892-3-3
64. НЕВЕРОВ, А. В. *Экономика природопользования*. Минск, 1990. 216 с.
65. РЕЙМЕРС, Н.Ф. *Природопользование. Словарь-справочник*. Москва, 1990. 637 с.
66. САВИНА, А. *Рациональное использование водных ресурсов как фактор регионального развития*: Дис. д-ра. экон. наук. Оренбург, 2004 166 с.
67. ХАЧАТУРОВ, Т.С. *Экономика природопользования*. Москва: Экономика, 1982. 271с. ISBN 5-211-015029

List of scientific papers on the thesis topic

Collective specialist books

1. BACAL, Petru, MOGÎLDEA, Vladimir, JELEAPOV, Ana, **BURDUJA, Daniela**, et al. ***Starea și utilizarea sistemelor de aprovizionare cu apă și sanitație din ecosistemele urbane și rurale din Regiunea de Dezvoltare Nord a Republicii Moldova.*** Cap. 1. *Materiale și metode de cercetare,* pp. 8 – 13. Cap. 3. *Starea și utilizarea sistemelor publice de aprovizionare cu apă,* pp. 39 – 76. Cap. 4. *Starea și utilizarea sistemelor publice de evacuare și purificare a apelor reziduale,* pp. 77 – 104. Cap. 5. *Mecanismul economic de reglementare a folosințelor de apă,* pp. 105 – 136.

Chișinău, „ Impressum”, 2021, 162 p., total 10,18 c.a. (contribuția autorului 6,97 c.a.), ISBN 978-9975-62-438-1. Disponibil: https://adrnord.s3.eu-central-1.amazonaws.com/Monografia_AAS_web_2021.pdf

2. BACAL, Petru, LOZOVANU, Dorin (coordonatori). ***Regiunea de Dezvoltare Centru. Aspecte geografice, socio-economice și ecologice*.** Subcapitolul 1.6. *Resursele de apă și utilizarea acestora.* pp. 21-38. Subcapitolul 4.3 *Impactul asupra apelor*. pp. 113-131. Chișinău, Edit. Dira-Ap, 2020, 156 p., total 20, 49 c.a., (contribuția autorului 1,39 c.a.), ISBN 978-9975-3236-5-9. Disponibil: https://ieg.md/sites/default/files/2022-02/Bacal%20Monografie%20RDCentru%20%202020.pdf

3. BULIMAGA, Constantin**,** BACAL, Petru (coordonatori). ***Studiul diagnostic al ecosistemelor urbane și rurale din Regiunea de Dezvoltare Nord*.** Subcapitolul 1.2 *Resursele de apă și utilizarea acestora,* pp. 12 – 30. Subcapitolul 4.3 *Sursele de impact asupra resurselor de apă,* pp. 101-108. Chișinău, „ Impressum”, 2020, 123 p., total 7,54 c.a., (contribuția autorului 1,37 c.a.), ISBN 978-9975-3482-3-2. Disponibil: https://ibn.idsi.md/sites/default/files/imag_file/WEB_Final_SD%20RD%20Nord%20RED%20Bacal%2027.11.2020_0.pdf

Articles in scientific journals from the Web of Science database

1. BACAL, Petru, CIOCAN, Nadejda, **VÎRLAN, Daniela**. ***The socio-economic impacts on water resources in the Răut river basin***. In: *Academic Journal Present Environment and Sustainable Development,* Volume 10, No. 2, 2016, pp. 249-258, 0,42 c.a., ISSN 2284-7820. Disponibil: https://pesd.ro/articole/nr.10/nr.2/10432%20-Volume10_issue_2%2021_paper.pdf. Baze de date: DOAJ, EBSCO, ERIH Plus.

2. BACAL, Petru, **BURDUJA, Daniela**. ***Dynamics and branch structure of water consumption in the Republic of Moldova*.** In: *Academic Journal Present Environment and Sustainable Development,* Volume 11, No. 2, 2017, pp. 187-201, 0,63 c.a. ISNN 1843-5971, e-ISSN 2284-7820. Disponibil: http://archive.sciendo.com/PESD/pesd.2017.11.issue-2/pesd-2017-0036/pesd-2017-0036.pdf. Baze de date: DOAJ, EBSCO, ERIH Plus.

3. BACAL, Petru, JELEAPOV, Ana, **BURDUJA, Daniela**, MOROZ, Ivan. ***State and use of lakes from Central Region of the Republic of Moldova*.** In: *Academic Journal Present Environment and Sustainable Development,* Volume 13, No. 2, 2019, pp. 141 – 155, 0,80 c.a., ISSN 2284-7820. Disponibil: http://www.pesd.ro/articole/nr.13/nr.2/10432%20-Volume13_issue_2%2010_paper.pdf. Baze de date: DOAJ, EBSCO, ERIH Plus.

4. BACAL, Petru, **BURDUJA, Daniela. *The peculiarities of the use of water resources in the Dniester hydrographical district (sector of the Republic of Moldova).*** In: *Academic Journal Present Environment and Sustainable Development*, Volume 16, No. 2, 2022, pp. 159-171, 0,81 c.a., ISSN 2284-7820. Disponibil: https://pesd.ro/articole/nr.16/nr.2/pesd2022162012.pdf. Baze de date: DOAJ, EBSCO, etc.

5. **BURDUJA, Daniela**, BACAL, Petru, RAILEAN, Veronica. ***The particularities of water use in the Central Region of Republic of Moldova*.** In: *Academic Journal Present Environment and Sustainable Development*, Volume 14, No. 1, 2020, pp. 5-17, 0,60 c.a. ISSN 2284 – 7820. Disponibil: https://pesd.ro/articole/nr.14/nr.1/pesd2020141001.pdf. Baze de date: DOAJ, EBSCO, ERIH Plus.

Articole în reviste științifice din baze de date acceptate de către ANACIP

1. BACAL, Petru, **BURDUJA, Daniela. *The regional pecularities of water use in the Republic***

of Moldova. În: *Lucrările Seminarului Geografic „Dimitrie Cantemir”*, Ediția XXXVII, Vol. 46, Nr. 2. Iași, 2018, pp. 19-37, 0,92 c.a., ISSN 1222-989-X. Disponibil:http://www.seminarcantemir.uaic.ro/index.php/lsgdc/article/view/9/8. Baze de date: DOAJ, CEEOL, ULRICH'S.

2. BACAL, Petru, **BURDUJA, Daniela**, CIOCAN, Nadejda. ***The peculiarities of water use in the Răut river basin. (Republic of Moldova)***. In: *Central European Journal of Geography and Sustainable Development*, Volume 1, No. 1, 2019, pp. 13-24, 1,00 c.a., ISSN 2668-4322. Disponibil: https://cejgsd.org/Article_002_CEJGSD.pdf. Baze de date: DOAJ, CABELLS, ULRICH'S, ELSEVIER, ERIH Plus.

3. BACAL, Petru, JELEAPOV, Ana, **BURDUJA, Daniela.** ***Status and use of water supply and sewerage systems in the Northern Development Region of the Republic of Moldova***. In: *Central European Journal of Geography and Sustainable Development*, Volume 4, No. 1, 2022, pp. 23-40, 1,51 c.a., ISSN-L 2668-4322. Disponibil: https://cejgsd.org/CEJGSD_2022-04/01/article/02/23-41_fulltext.pdf. Baze de date: DOAJ, CABELLS, ULRICH'S, etc.

Articles in journals from the National Register of Journals

1. BACAL, Petru, RĂILEAN, Veronica, **BURDUJA, Daniela**. ***Evaluarea eficienței întreprinderilor de aprovizionare cu apă și sanitație din așezările urbane ale Regiunii de Dezvoltare Centru a Republicii Moldova***. (ro/engl). În: *Revista Economica*, Nr. 3, Editura ASEM, Chișinău, 2018, pp. 32 – 44, 1,1 c.a., ISSN 1810-9136. Disponibil: https://ase.md/files/publicatii/economica/ec_2018_3_r2.pdf. Categoria B

Articles in the papers of scientific events included in the Register of materials published on the basis of scientific events organized in the Republic of Moldova

1. BACAL, Petru, **BURDUJA, Daniela**. ***Aplicarea sancțiunilor contravenționale pentru încălcarea legislației de folosință și protecție a resurselor de apă în Regiunea de Dezvoltare Nord a Republicii Moldova.*** În: Seminarul*"Dezvoltarea umană în Republica Moldova din perspectiva resurselor naturale, socio-economice și turistice"* din 16 aprilie 2021, Chișinău, 2021, pp. 7-11, 0,39 c.a. ISBN 978-9975-76-355-4 (PDF). Disponibil: https://ibn.idsi.md/vizualizare_articol/140989

2. BACAL, Petru, **BURDUJA, Daniela.** ***Particularitățile regionale ale captării și distribuției resurselor de apă în Republica Moldova*.** În: Conferinţa ştiinţifică naţională cu participare internaţională *„Știința în Nordul Republicii Moldova: realizări, probleme, perspective”*, din 20-21 mai 2022, Ediția 6, Bălți, 2022. pp. 288-292, 0,44 c.a., ISBN 978-9975-3465-5-9. Disponibil: https://ibn.idsi.md/vizualizare_articol/157653

4. BACAL, Petru, **BURDUJA, Daniela.** ***Realizări și probleme în reformarea cadrului legal și instituțional în domeniul gestionării resurselor de apă ale Republicii Moldova.*** În: Simpozionul Științific Internațional *"Reglementarea utilizării resurselor naturale: realizări şi perspective"*, din 30 septembrie – 1 octombrie, Volumul 55, Cadastru şi drept, 2022, pp. 502-505, 0,36 c.a., ISBN 978-9975-64-328-3. Disponibil: https://ibn.idsi.md/vizualizare_articol/147468

5. BACAL, Petru, RAILEAN, Veronica, **BURDUJA, Daniela**. ***Mecanismul de reglementare economică a utilizării apelor în BH Răut (în limitele RD Centru)***. În: Conferința „*Starea actuală a componentelor de mediu”* din 12-13 decembrie 2019, Chișinău, 2019, pp. 254-263, 0,52 c.a., ISBN 978-9975-3155-9-3. Disponibil: https://ibn.idsi.md/vizualizare_articol/93119

6. **BURDUJA, Daniela**, BACAL, Petru ***Starea și utilizarea surselor necentralizate de aprovizionare cu apă în Regiunea de Dezvoltare Nord***. În: Conferința științifică națională cu participare internațională *„Știința în Nordul Republicii Moldova: realizări, probleme, perspective”*, din 29-30 iunie 2021, Ediția 5, Bălți, 2021, pp. 252 – 257, 0,40 c.a., ISBN 978-9975-62-432-9. Disponibil: https://ibn.idsi.md/vizualizare_articol/142290

7. **BURDUJA, Daniela.** ***Resursele de apă subterană din Regiunea de Dezvoltare Nord și particularitățile exploatării acestora*****.** În: Conferința științifică națională cu participare internațională *„Știința în Nordul Republicii Moldova: realizări, probleme, perspective”* din 20-21 mai 2022, Ediția 6, Bălți, 2022, pp. 321-325, 0,35 c.a., ISBN 978-9975-3465-5-9. Disponibi: https://ibn.idsi.md/vizualizare_articol/157669

8. **BURDUJA, Daniela.** ***Impactul activităților socio-economice asupra resurselor de apă din Regiunea de Dezvoltare Nord.*** În: Culegerea de articole a Seminarului Științific *„Evaluarea și reglementarea impactului antropic asupra stabilității ecosistemelor urbane și rurale din Regiuneade Dezvoltare Nord a Republicii Moldova”* din 10 octombrie 2022, Chișinău, 2022, pp. 57-62, 0,30 c.a., ISBN 978-9975-3586-0-6.

9. **BURDUJA, Daniela.** ***Analiza aplicării amenzilor pentru încălcarea legislației de folosință și protecție a apelor în Regiunea de Sud a Republicii Moldova.*** În: Simpozionului Științific Internațional *„Zonele umede valori perene cu rol vital pentru omenire”* din 11-12 noiembrie 2021, Chișinău, 2021, pp. 45 – 50, 0,28 c.a., ISBN 978-9975-72-598-9. Disponibil: https://ibn.idsi.md/vizualizare_articol/164562

10. **BURDUJA, Daniela**, BACAL, Petru. ***The influence of the urban centers from the Central Development Region on the consumption of water resources***. În: Culegerea de articole a Simpozionului Științific Internațional al Tinerilor Cercetători ediția a XVII-a din 24-25 aprilie, 2019, ASEM, Chișinău, 2019, pp. 232-238, 0,15 c.a., ISBN 978-9975-75-962-5. Disponibil: https://ibn.idsi.md/sites/default/files/imag_file/232-238_2.pdf

11. **BURDUJA, Daniela**, BACAL, Petru, JELEAPOV(CHIȘCIUC), ANA. ***Particularitățile utilizării resurselor de apă în Regiunea de Dezvoltare Nord a Republicii Moldova***. În: Conferința *“Provocări și tendințe actuale în cercetarea componentelor naturale și socio-economice ale ecosistemelor urbane și rurale”* din 23 iunie 2020, Chișinău, 2020, pp. 113-120, 0,47 c.a., ISBN 978-9975-89-160-8. Disponibil: https://ibn.idsi.md/vizualizare_articol/116555

12. **BURDUJA (VÎRLAN), Daniela,** BACAL, Petru, CIOCAN, Nadejda. ***Particularitățile utilizării resurselor de apă în BH Răut (în limitele RD Centru).*** În: Conferința „*Impactul antropic asupra calității mediului”* din 19 februarie 2019, Chișinău, 2019, pp. 270-280, 0,58 c.a., ISBN 978-9975-3308-0-0. Disponibil: https://ibn.idsi.md/vizualizare_articol/87821

13. **BURDUJA, Daniela**, JELEAPOV, Ana, BACAL, Petru. ***Particularitățile utilizării apei în bazinul hidrografic al râului Cubolta*****.** În: Conferința Științifică Internațională *"Mediul și Dezvoltarea Durabilă"*, Ediția 5, Chișinău, 2020, pp. 21-25, 0,28 c.a., ISBN 978-9975-76-315-8. Disponibil: https://ibn.idsi.md/ro/vizualizare_articol/113795/datacite

14. **BURDUJA, Daniela**, RAILEAN, Veronica, BACAL, Petru. ***Analiza SWOT a serviciilor de alimentare cu apă și sanitație prestate de întreprinderile Asociației Moldova Apă-Canal în Regiunea de Dezvoltare Centru.*** În: Conferința Științifică Internațională *„Competitivitatea și Inovarea în Economia Cunoașterii”* din 28-29 septembrie 2018, ASEM, Chișinău, 2018, Vol. I, pp 267 – 273, 0,69 c.a., e-ISBN 978-9975-75-926-7. Disponibil:

15. **BURDUJA, Daniela**, RAILEAN, Veronica, BACAL, Petru. ***The particularities of water consumption in the center region of development of the Republic of Moldova***. În: Culegerea de articole a Simpozionului Științific Internaţional al Tinerilor Cercetători, ediţia a XVI-a din 27-28 aprilie 2018, ASEM, Chişinău, 2018, pp 267 – 273, 0,37 c.a, e-ISBN 978-9975-75-926-7. Disponibil: https://ibn.idsi.md/vizualizare_articol/89884

16. JELEAPOV(CHIȘCIUC) Ana, **BURDUJA, Daniela**. ***Starea acumulărilor de apă din bazinul hidrografic al râului Căinari***. În: Conferinţa ştiinţifică naţională cu participare internaţională *„Știința în Nordul Republicii Moldova: realizări, probleme, perspective”* din 29-30 iunie 2021, Ediția 5, pp. 294 – 299, 0,24 c.a., ISBN 978-9975-62-432-9. Disponibil: https://ibn.idsi.md/vizualizare_articol/142312

17. JELEAPOV, Ana, **BURDUJA, Daniela**. ***Resursele de apă ale râurilor din Regiunea de Dezvoltare Nord.*** În: Conferința*“Provocări și tendințe actuale în cercetarea componentelor naturale și socio-economice ale ecosistemelor urbane și rurale”* din 23 iunie 2020 Chișinău, 2020, pp. 58-63, 0,25 c.a., ISBN 978-9975-89-160-8. Disponibil: https://ibn.idsi.md/vizualizare_articol/116538

18. JELEAPOV(CHIȘCIUC), Ana, **BURDUJA, Daniela**. ***Starea acumulărilor de apă din bazinul hidrografic al râului Cubolta.*** În: Conferința Științifică Internațională *"Mediul și Dezvoltarea Durabilă"*, Ediția 5, Chișinău, 2020, pp. 43-47, 0,18 c.a., ISBN 978-9975-76-315-8. Disponibil: https://ibn.idsi.md/vizualizare_articol/113804

19. RAILEAN, Veronica, **BURDUJA, Daniela**, JELEAPOV(CHIȘCIUC), Ana, BACAL, Petru. ***Economic analysis of water supply and sanitation services in the central development region of the Republic of Moldova***. În: Culegerea de articole a Simpozionului Științific Internaţional al Tinerilor Cercetători, ediţia a XVI-a din 27-28 aprilie 2018, ASEM, Chişinău, 2018, pp 259 – 266, 0,43 c.a., e-ISBN 978-9975-75-926.

Other specific works and achievements in different scientific fields

1. BACAL, Petru, **BURDUJA, Daniela**, et. al. ***Studiul impactului social și de mediu al complexului hidroenergetic nistrean. Rezumat non-tehnic***. PNUD Moldova, Chișinău, 2022, 34 p. ISBN 978-9975-87-937-8 (PDF). 1,10 c.a. Disponibil: https://www.undp.org/sites/g/files/zskgke326/files/migration/md/Nistru_Sumar_RO-final_.pdf

2. BACAL, Petru, **BURDUJA, Daniela**, et. al. ***Dniester Hydro Power Complex Social and Environmental Impact Study: Non-technical Summary***. UNDP Moldova, Chișinău, 2022, 34 p. 1,0 c.a. ISBN 978-9975-87-938-5 (PDF). Disponibil: https://www.undp.org/sites/g/files/zskgke326/files/migration/md/Nistru_Sumar_EN-final_.pdf

3. БАКАЛ, Петру, **БУРДУЖА, Даниела,** и др. ***Исследование социальных и экологических воздействий Днестровского Гидроэнергетического Комплекса: Нетехническое резюме.*** ПРООН Молдова, Кишинэу, 2022, 34 с. 1,10 с.а., ISBN 978-9975-87-939-2 (PDF). Disponibil: https://www.undp.org/sites/g/files/zskgke326/files/migration/md/Nistru_Sumar_RU-final_.pdf

Adnotare

BURDUJA Daniela, „Aspecte economico-geografice ale valorificării și gestionării resurselor de apă ale Republicii Moldova”, teză de doctor în Științe ale Pământului, Chișinău, 2023

Structura tezei: Teza este constituită din introducere, 5 capitole, concluzii generale și recomandări, bibliografie din 233 de titluri, 41 anexe, 161 pagini de text de bază, 52 de figuri, 18 tabele. Rezultatele obținute în urma cercetărilor la tema tezei au fost publicate în 33 de lucrări științifice.

Cuvinte-cheie: resurse de apă, captare, utilizare, gestionare, regiuni, bazine hidrografice.

Scopul lucrării: Aprecierea economico-geografică complexă a valorificării și gestionării resurselor de apă ale Republicii Moldova.

Obiective: 1. Crearea suportului informațional și metodologic pentru aprecierea economico-geografică a valorificării și gestionării resurselor de apă; 2. Evaluarea resurselor de apă de suprafață și subterane în profil național, regional și bazinal; 3. Analiza spațială (pe unități administrativ-teritoriale și hidrografice) și ramurală a captării și utilizării resurselor de apă; 4. Aprecierea mecanismului actual de gestionare a resurselor de apă și principalelor componente ale acestuia; 5. Elaborarea recomandărilor pentru utilizarea durabilă si gestionarea mai eficientă a resurselor de apă.

Noutatea și originalitatea științifică. A fost realizat un studiu amplu și interdisciplinar privind utilizarea și gestionarea resurselor de apă ale Republica Moldova, care cuprinde o analiză spațială complexă (regională și bazinală) a captării și utilizării apelor, precum și a instrumentelor principale ale mecanismului de gestionare a resurselor de apă.

Rezultatul obținut constă în aprecierea economico-geografică complexă a utilizării și gestionării resurselor de apă ale Republicii Moldova în condițiile actuale ale tranziției socio-economice îndelungate și intensificării schimbărilor climatice. Au fost evaluate tendințele principale ale utilizării apelor după sursele de proveniență și categoriile de folosință. Au fost identificate carențele principale ale sistemului informațional, ale exploatării sistemelor de captare și utilizare a apelor și ale aplicării mecanismului de gestionare în domeniu, propuse recomandări de prevenire și atenuare a acestor lacune.

Semnificația teoretică. Teza reprezintă un studiu interdiscplinar, care are la bază aprecierea complexă a resurselor de apă și a particularităților actuale de utilizare și gestionare a acestora în profil regional și bazinal. Această lucrare va contribui semnificativ la actualizarea și aprofundarea studiilor economico-geografice autohtone și a geografiei resurselor naturale în Republica Moldova.

Valoarea aplicativă. Rezultatele cercetărilor pot fi utilizate în elaborarea Planurilor de Gestionare a districtelor și bazinelor hidrografice, Programelor Regionale Sectoriale și Planurilor Locale de Acțiuni în domeniul aprovizionării cu apă. Rezultatele și baza de date ale acestei lucrări pot fi foarte utile în elaborarea rapoartelor privind progresele în domeniul aprovizionării cu apă, inclusiv a documentelor de politici privind valorificarea durabilă a resurselor de apă în contextul schimbărilor climatice și socio-economice.

Implementarea rezultatelor științifice. Rezultatele obținute în urma cercetărilor efectuate la tema tezei au fost utilizate cu succes la realizarea Proiectelor instituționale aplicative „Studiul impactului activităților economice a Regiunii de Dezvoltare Centru în scopul protejării potențialului natural pentru asigurarea dezvoltării durabile”(2016-2019) și „Evaluarea stabilității ecosistemelor urbane și rurale în scopul asigurării dezvoltării durabile” (2020-2022) realizate în cadrul Institutul de Ecologie și Geografie, precum și în Proiectul „Studiul de impact social și de mediu al Complexului Hidroenergetic Nistrean (CHN)”, finanțat de Ambasada Suediei în Republica Moldova și implementat de PNUD Moldova în parteneriat cu Ministerul Mediului (anii 2020-2021). De asemenea, rezultate științifice obținute la teza de doctorat sunt confirmate prin Acte de Implementare la ADR Nord și ADR Centru.

Aprobarea rezultatelor științifice. Rezultatele principale ale cercetărilor științifice obținute în prezentul proiect doctoral au fost aprobate la numeroase manifestații științifice naționale și internaționale, printre care menționăm: Simpozionul Internațional „Present Environment and Sustanaible Development”, UAIC, Iași (2017-2022); Seminarul Geografic Internațional „D. Cantemir”, UAIC, Iași (2019, 2021); Simpozionul Internațional „Sisteme Informaționale Geografice”, UAIC, Iași, 2018, UST, Chișinău (2021); Simpozionul Științific al Tinerilor Cercetători, ASEM, Chișinău, (2016, 2018, 2019); Conferința "Competitivitatea și Inovarea în Economia Cunoașterii", ASEM, Chișinău, 2018; Conferința "Mediul și Dezvoltarea Durabilă", UST, Chișinău, 2020; Conferința Științifică „Știința în Nordul Republicii Moldova: realizări, probleme, perspective”, Filiala Nord a AȘM, Bălți, (2019-2022). De asemenea, rezultate tezei sunt expuse în peste 30 de publicații științifice, inclusiv 5 indexate în reviste Web of Science.

Аннотация

BURDUJA Daniela, „Экономико-географические аспекты эксплуатации и управления водными ресурсами Республики Молдова", докторская диссертация в области Наук о Земле, Кишинэу, 2023

Структура диссертации: Диссертация состоит из введения, 5 глав, общих выводов и рекомендаций, библиографии из 233 наименований, 41 приложения, 161 страниц основного текста, 52 рисунков, 18 таблиц. Результаты, полученные в результате исследований по теме диссертации, опубликованы в 33 научных работах.

Ключевые слова: водные ресурсы, забор, использование, управление, регионы, бассейны

Цель статьи: Комплексная экономико-географическая оценка использования и управления водными ресурсами Республики Молдова..

Задачи: 1. Создание информационно-методической основы экономико-географической оценки эксплуатации и управления водными ресурсами; 2. Оценка поверхностных и подземных водных ресурсов в национальном, региональном и бассейновом разрезе; 3. Пространственный (по административно-территориальнымм и гидрографическим единицам) и отраслевой анализ забора и использования водных ресурсов; 4. Оценка существующего механизма управления водными ресурсами и его основных компонентов; 5. Разработка рекомендаций по более эффективному использованию и управлению водными ресурсами.

Научная новизна и оригинальность. Было проведено обширное и междисциплинарное исследование в области использования и управления водными ресурсами Республики Молдова, которое включает комплексный пространственный (региональный и бассейновый) анализ забора и использования водных ресурсов, а также основных экономические инструментов их управления.

Полученный результат, способствующий решению научной задачи, состоит в комплексном экономико-географической использования и управления водными ресурсами Республики Молдова, в условиях длительного социально-экономического перехода и интенсификации климатических изменений. Были определенны главные тенденции использования водных ресурсов в зависимости от источников водозабора и отраслевому использованию, Выявлению островные недостатки информационного обеспечения, системы эксплуатации систем водозабора и водопользования, а также механизма управления в этой области и предложены рекомендации по их устранению.

Теоретическая значимость. Представленная работа имеет междисциплинарный характер, в основа которого является комплексная оценка водных ресурсов и современных особенностей их использования в и управления на региональном и бассейновом уровнях. Эта работа принесет существенный вклад в актуализации и углублении экономическо-географических исследований и географии природных ресурсов Республики Молдова

Практическая значимость. Результаты исследования могут быть использованы при разработке Планов Управления гидрографическими бассейнами, Региональных Отраслевых Программ и Местных Планов Действий в области водоснабжения. Результаты и база данных этой работы могут быть очень полезны при разработке отчетов о ходе реализации программ по водоснабжению, включая программные документы по устойчивому использованию водных ресурсов в контексте современных социальных-экономических и климатических изменений.

Внедрение научных результатов. Результаты, полученные в процессе исследования, проведенного по теме диссертации, были успешно использованы при реализации прикладного институционального Проекта «Оценка устойчивости городских и сельских экосистем в целях обеспечения устойчивого развития» (2020-2022 гг.), и «Изучение влияния хозяйственной деятельности центрального региона развития на охрану природного потенциала для обеспечения устойчивого развития» (2016-2019 гг.), а так же в проекте «Изучение социальной и экологической воздействия Днестровского гидроэнергетического комплекса (ДГЭК)» (2021).

Утверждение научных результатов. Научная ценность исследования была подтверждена на национальных и международных научных мероприятиях, в т,ч на.: Международной Конференции „Present Environment and Sustanaible Development", Яссы (2017-2022); Международный Географический Семинар «Д. Кантемир», Яссы (2019, 2021); Международном Симпозиуме «Географические Информационные Системы», Яссы (2018) и Кишинэу (2021); Научном Симпозиуме Молодых Ученых, Кишинэу, (2016, 2018, 2019); Конференции «Конкурентоспособность и инновации в экономике знаний», Кишинэу, 2018 г.; Конференции «Окружающая среда и устойчивое развитие», Кишинев, ТГУ, 2020 г и др.

Annotation

BURDUJA Daniela, "Economic and geographical aspects of the valorization and management of water resources of the Republic of Moldova", doctoral thesis in earth sciences, Chisinau, 2022

Structure of the thesis: The thesis consists of introduction, four chapters, general conclusions and recommendations, bibliography of 233 titles, 41 annexes, 161 pages of basic text, 52 figures, 18 tables. The results obtained from research on the topic of the thesis were published in 33 scientific works.

Key words: water resources, abstraction, use, management, regions, river basins.

The purpose of the paper. The complex economic-geographic assessment of the exploitation and management of the water resources of the Republic of Moldova.

Objectives: 1. Creation of informational and methodological support for the economic-geographic assessment of the exploitation and management of water resources; 2. Evaluation of surface and underground water resources in a national, regional and basin profile; 3. Spatial (by administrative and hydrographic units) and branch analysis of the capture and use of water resources; 4. Appreciation of the current water resource management mechanism and its main components; 5. Elaboration of recommendations for the sustainable use and more efficient management of water resources.

Scientific novelty and originality. Was carried out a comprehensive and interdisciplinary study on the use and management of water resources of the Republic of Moldova, including a complex spatial analysis (regional and basin) of water abstraction and use, as well as the main instruments of the water resources management mechanism.

The result obtained consists in a complex economic-geographical assessment of the use and management of water resources of the Republic of Moldova in the current conditions of long socio-economic transition and intensification of climate change. The main trends of water use by source and use categories were assessed. The main shortcomings of the information system, the operation of water catchment and use systems and the application of the water management mechanism were identified, and recommendations to prevent and mitigate these shortcomings were proposed.

Theoretical significance. The thesis is an interdisciplinary study, based on a complex assessment of water resources and their current use and management features in regional and basin profile. This work will contribute significantly to the updating and deepening of the local economic-geographical studies and the geography of natural resources in the Republic of Moldova.

Application value. Research results can be used in the development of hydrographic District and Basin Management Plans, Regional Sector Programmes and Local Water Supply Action Plans. The results and database of this work can be very useful in the preparation of water supply progress reports, including policy documents on sustainable water resources development in the context of climate and socio-economic change.

Implementation of scientific results. Institutional projects "Study of the impact of economic activities of the Central Development Region in order to protect the natural potential for ensuring sustainable development" (2016-2019) and "Assessment of the stability of urban and rural ecosystems for ensuring sustainable development" (2020-2022) carried out in the framework of the Institute of Ecology and Geography, as well as in the Project "Social and environmental impact study of the Dniester Hydropower Complex", funded by the Embassy of Sweden in the Republic of Moldova and implemented by UNDP Moldova in partnership with the Ministry of Environment (2020-2021). Also, scientific results obtained in the PhD thesis are confirmed by Implementation Acts at North RDA and Central RDA.

Approval of scientific results. The main results of the scientific research obtained in this PhD project have been approved at numerous national and international scientific events, among which we mention: International Symposium "Present Environment and Sustainable Development", UAIC, Iași (2017-2022); International Geographic Seminar "D. Cantemir", UAIC, Iasi (2019, 2021); International Symposium "Geographic Information Systems", UAIC, Iasi, 2018, UST, Chisinau (2021); Scientific Symposium of Young Researchers, ASEM, Chisinau, (2016, 2018, 2019); Conference "Competitiveness and Innovation in the Knowledge Economy", ASEM, Chisinau, 2018; Conference "Environment and Sustainable Development", UST, Chisinau, 2020; Scientific Conference "Science in the North of the Republic of Moldova: Achievements, Problems, Perspectives", Northern Branch of the ASM, Balti, (2019-2022). Also, thesis results are exposed in more than 30 scientific publications, including 5 indexed in Web of Science journals.

BURDUJA DANIELA

ECONOMIC AND GEOGRAPHICAL ASPECTS OF THE VALORIZATION AND MANAGEMENT OF WATER RESOURCES OF THE REPUBLIC OF MOLDOVA

154.01 SOCIAL AND ECONOMIC GEOGRAPHY

Abstract of the PhD thesis in Earth Sciences

Approved for printing: 16.01.2023. Offset paper. Printing Offset. Printing author's sheets: 1,9.	Paper format: 60x84 1/16. Tiraj: 10 ex. Order no.: 7.

The Editorial-Polygraphic Service of
Academy of Economic Studies of Moldova
Chisinau, 59 Banulescu-Bodoni Str., MD-2005