Chapter 1
Integrated Water Management in the Republic of Moldova

Gheorghe Duca, Oleg Bogdevich and Diana Porubin

Abstract Water management aspects in Republic of Moldova are discussed. The aim of the article is to review the institutional capacity for water monitoring and management of water resources in Moldova. The characteristics of water monitoring network is presented and some aspects for the improvement of existing monitoring capacity are examined. The complex character of actual water management in the Republic of Moldova is determined and the role of scientific support for the problem solving in this field is proposed.

Keywords Water management and monitoring · Water resources · Institutional analysis · Quality indicators

1.1 Introduction

The groundwater management is very important for the countries with arid and semiarid climate. The climate change will impact on surface and groundwater balance. Periods with extremely high precipitation or strong drought will be more frequent and long. In this case, the respective Integrated Water Resource Management plays an important part in the economy development of every country. Water quality and quantity in any country is a critical factor affecting human health and welfare. Access to the water sources in Moldova is one of the important

G. Duca
Academy of Sciences of Moldova, 1 Stefan cel Mare Ave., Chisinau, Moldova

O. Bogdevich (✉)
Institute of Geology and Seismology, Academy of Science of Moldova,
60/3 Gh. Asachi Street, Chisinau, Moldova
e-mail: bogdevicholeg@yahoo.com

D. Porubin
Institute of Chemistry, Academy of Sciences of Moldova, 3 Academiei Street,
Chisinau, Moldova

G. Duca (ed.), *Management of Water Quality in Moldova*,
Water Science and Technology Library 69, DOI: 10.1007/978-3-319-02708-1_1,

problems because our country ranks one of the last places in the Europe on number of sources of water per capita. Quality of surface and underground waters of the country in most cases mismatches state, European and international standards (UNESCO, the International Health Organization, etc.). The water resources are determined by the number of factors, including amount of water received from precipitation, inflow and outflow in rivers ant the amount lost by evaporation and transpiration. Republic of Moldova is located in South-East of Europe, in a region with insufficient precipitation, limited water resources, with tempered climate and relatively limited humidity [1]. The precipitation regime is very instable last time. Thus 2007 year is characterized by strong drought with average precipitation volume of 62–170 mm (35–85 % of yearly volume). Three years from every ten are drought-afflicted here. At the same time tremendous downfalls are took place with the precipitation more then 200 mm per day.

The management of a river basin requires that all movement of water, both natural and artificial, be monitored. The natural components include precipitation, river flow and groundwater levels, and the artificial components include abstractions and discharges. At many enterprises and in rural area there are no waste-water treatment facilities or they are in an unsatisfactory condition. Most wastewater discharges into surface waters in Moldova are municipal; enterprises usually discharge their wastewater into mixed municipal sewer systems.

In the Republic of Moldova there is no adequate legislative base for water management, maintenance of drinking water, implementation of modern technologies on water treatment. Moldova has taken a decision to align its legislation more closely with that of the European Union. Within this context Moldova has developed a Water Legislation for the implementation of the Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the Water Framework Directive of EU). The EU Water Framework Directive (WFD) aims at a "good" status for surface waters. Good status implies good chemical as well as biological quality. For groundwater good status implies good chemical quality and sufficient quantity. To achieve the environmental objectives, the Directive makes it clear that an integrated approach to sustainable water management is necessary.

It also has taken on increased obligations in terms of River Basin Management (RBM). The main aim of the developed water legislation is to allow a coherent and harmonious implementation of this Directive. The focus of this article is on methodological questions related to a common understanding of the technical and scientific implications of the Water Framework Directive. These are reflected in the draft Water Law, which is currently being processed in the Moldovan Parliament. The current Water Code does not provide for RBM, while the draft Water law, once adopted, will create the legal framework for RBM implementation. Negotiations are ongoing between Moldova and the EU regarding an association agreement.

The quality and quantity of natural water resources is sufficient in the general for the sustainable development of Moldova. There are transboundary rivers Prut and Nistru, small rivers and lakes, shallow and deep groundwaters. However it is distributed irregular by country. South part of country is in semiarid zone with the deficiency of good water for different purposes: drinking, irrigation, industrial, etc. It should be noted that more than 30 % of groundwater sources, providing the city with drinking water, do not meet the quality requirements for chemical indicators that more than 70–80 % of wells, are not suitable, and often dangerous to use for drinking purposes. The shallow ground waters on a greater part of territory of the country are polluted by anthropogenous sources, in particular nitrates.

The Global Water Partnership defines Integrated River Basin Management (IRBM) as a "process of coordinating conservation, management and development of water, land and related resources across sectors within a given river basin, in order to maximize the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems". The main objective of IRBM is to establish a balance between the existing natural functions of the river system and the developed aspects of the system. The management actions should fulfill the expectations of the society for industrial use, recreation, nature management, and agricultural purposes.

Integrated Water Resources Management (IWRM) is conceptually similar to, but not completely synonymous with IRBM. In the case of River Basin Management, the focus is on the hydrological basin: in the case of Water Resources Management the focus is on the water resources. However, since IWRM recognizes the importance of management at the level of river basins, the outcomes would be the same. The aim of the proposed article is an analysis of the state with IWRM in Republic of Moldova and proposal development for the scientific support of legislative and technical improvement of water management issues.

1.2 Institutional Analysis

The different key water management institutions in Moldova include a range of public authorities such as: Ministry of Environment and its subordinated institutions (i.e. *Apele Moldovei* Agency, Agency for Geology and Mineral Resources, State Ecological Inspectorate, State Hydrometeorological Service, Fishery Service, Hydrogeological Expedition "EHGeoM", Institute of Ecology and Geography), Ministry of Health and Agency of Land Relations and Cadastre. Other public institutions with water-related functions include the Ministry of Agriculture and Food Industry, the Ministry of Regional Development and Constructions, and the Ministry of Internal Affairs, among others. And, the local public administration is vested with several water resources management-related responsibilities such as: management of surface water and water supply and sanitation at local level. The new Water Law (adopted in 2011) will create the legal framework for the river basin management implementation in Moldova harmonized with EU water Acts. It will have a series of implications on the future institutional framework and on water resources management practices.

The cooperation between Moldavian institutions is weak and there are no formal agreements for water-related data exchange. Three institutions are jointly responsible for elaboration and editing of the State Water Cadastre on an annual basis: Apele Moldovei Agency (Water Basin Management Department); State Hydrometeorological Service; and State Agency for Geology and Mineral Resources.

New divisions have been set up within the Ministry of Environment (ME) and Apele Moldovei Agency with the specific aim of enhancing the country's management of river basins. However, these new divisions, as they are presently constituted, are not likely to be able to fulfill all the tasks required in the development of a comprehensive river basin management plan. It is likely that additional specialists will need to be recruited with qualifications in specific disciplines: IT and database specialist, GIS specialist, hydrology and hydrogeology modeler, risk assessors, etc.

The aspect of water management was presented in different technical reports and publications by international projects in Moldova [2–11]. The technical and financial support to State Hydrometeorological Service was made for the installation of some hydrometric stations with remote data transmission on the Prut, Nistru and Raut rivers for the monitoring of surface water and protection against flood. But actually the remote data transfer is not working by technical problems.

The published reports indicated [2] that there are a number of gaps in the present institutional framework, which refer, in particular, to the following [2]:

- Identification and delimitation of water bodies;
- Establishing objectives for water resources (river basin) management;
- River basin planning;
- Flood risk management;
- Interaction with stakeholders.

There are a few proposals for the delimitation of the two river basin districts—the Danube/Prut and the Nistru—but pending the adoption of the draft Water Law, an official decision on the subject may not be taken, since none of the existing institutions carries this function under the present legal framework. The same applies to the identification and delimitation of water bodies and to the setting of objectives. The flood risk management is presented actually only by the provision of warnings and response measures. Prevention measures, including the assessment of flood risks, the identification of flood-risk areas, and flood management planning, are not envisioned in the near future.

The process of authorization obtaining for water and groundwater users is cumbersome because it is in the hands of several institutions, including institutions of the ME and others, such as the Ministry of Health. Water users should to visit several institutions in order to obtain their endorsement of an application. The responsibility for obtaining the approvals lies on the applicant, who first has to put together the documents needed in support of the application, and then to visit each institution before filing the application with the Inspectorate, together with the approvals and/or recommendations of the institutions. This procedure should to be simplified in the mode of the "single window".

Often both resource management and development functions are in the hands of one and the same institution, there is no way to assess performance, because the institution is at the same time a poacher and a gamekeeper (i.e., the controlled and the controller, responsible for supervising its own activities). Thus, there is no transparency and, in principle, it is difficult to ascertain whether water resources are developed and used in a sustainable manner, and whether the water services rendered to the end users are satisfactory.

To manage a river basin in an integrated way requires a wide variety of specialized skills. Many of these skills have been practiced in Moldova for years: monitoring of river flows, aquifer yields, taking samples of water for laboratory analysis, GIS elaboration and others. With the introduction of new equipment or more stringent water quality requirements some of these skills will need to upgraded; this is perfectly normal and many professional associations in Europe place emphasis on continuing professional development. Other skills, related to ecology or hydro-morphology, for example, will have to be developed. Developing these skills is likely to involve a cooperative approach between the Governmental authorities, universities and other academic institutions possibly involving training outside of Moldova.

1.3 Water Monitoring and Data Management

The water management on the river basin level requires than all waters should to be monitored: surface and ground water, natural, technological, waste water, etc. The summary of water abstraction from both surface water and groundwater is provided in Table 1.1. Table 1.2 summaries the discharge to rivers. While it does indeed suggest that there has been a decline in the percentage of waste treated, it is possible that the real situation might be more severe than the table suggests.

Table 1.1 Water consumption in Moldova during 2001–2008 (million m^3)*

Year	2001	2002	2003	2004	2005	2006	2007	2008
Number of water consumers, units	2535	2533	2549	2554	2547	2555	2507	2519
Water abstracted—total	874	866	864	852	852	854	885	861
• of which, water abstracted from groundwater	138	132	135	136	136	136	129	127
Water consumption (use)—total	797	792	795	786	785	787	809	794
• for production needs	587	587	586	585	583	583	581	581
○ of which, drinking water	19	20	20	20	18	17	17	17
• water supply for agriculture	36	36	35	36	35	36	36	37
• water supply for households needs and for drinking	130	120	116	115	120	120	125	124
Losses during transportation	71	68	64	62	61	61	69	64
Quantity of water in circulation and re-used	367	368	338	360	350	358	365	359

**Source*: Statistical Yearbook of the Republic of Moldova (2009)

Table 1.2 Summary of wastewater discharges in Moldova during 2001–2008 (million m^3)*

Year	2001	2002	2003	2004	2005	2006	2007	2008
Total, of which:	708	696	685	688	690	695	687	686
Conventionally pure waters (without purification)	557	560	558	561	556	562	551	550
Polluted waters	13	19	48	42	9	7	10	14
Without purification	0.3	0.5	0.8	0.5	0.6	0.5	0.7	0.8
Insufficiently purified	12.6	18.9	47.5	41.4	8.3	6.7	9.2	13.3
Conventionally purified waters	138	116	79	85	124	119	119	115
Conventionally purified sewage waters, in % of the total volume of water liable for purification	91 %	86 %	62 %	67 %	93 %	89 %	88 %	85 %

**Source*: Statistical Yearbook of the Republic of Moldova, 2009

Most wastewater discharges into surface waters in Moldova are municipal. Enterprises usually discharge their wastewater into mixed municipal sewer systems. Other discharges of wastewater directly into surface waters mainly concern wineries and food industry. In 2010, 69 290 000 m^3 of municipal wastewater was treated, out of which 6 % (4 151 000 m^3) was treated insufficiently. However, the overall statistics are dominated by the wastewater treatment of the city of Chisinau, which accounts for 81 % of the total municipal wastewater volume. When excluding "Apa-Canal Chisinau", then 30 % of the remaining volume of 13 379 000 m^3 is treated insufficiently. Actually, in 20 of the 33 settlements mentioned in Table 1.3, all (100 %) of the wastewater is insufficiently treated; in 7 settlements there is no wastewater treatment at all.

In 2008, the regulation on conditions for urban wastewater discharge into natural receiving waters was adopted. This regulation has been largely based on the EU Directive 91/271/EEC concerning urban wastewater treatment. The regulation prescribes emission limit values for biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), and total suspended solids. In line with the EU Directive 91/271/EEC, also emission limit values for total phosphorus and total nitrogen are included for discharges from urban wastewater treatment plants into sensitive areas; however, the regulation does not provide with criteria for sensitive areas. The regulation on conditions for urban wastewater discharge into natural receiving waters has been adopted more than 2 years ago, sensitive areas have been not yet designated.

According to the regulation on conditions for urban wastewater discharge into natural receiving waters requirements for the wastewater quality apply only to municipal wastewater discharges into receiving surface waters that are not used for drinking and recreation purposes. All other operators shall calculate emission limit values for a long range of parameters, based on the maximum allowable concentrations (MAC) for fishery that were established in the Soviet Union [2].
The Regulation on conditions for urban wastewater discharge into natural receiving waters has prescribed the requirements for the monitoring of discharges from treatment plants to be conducted by the operator, including self-monitoring.

Table 1.3 Overview of municipal wastewater discharges per river district in Moldova in 2010 [2]

Nr	Wastewater source (town)	Population in 2010 (ths)	Biologically treated (thousand m^3)			Discharged into			
			Total	Conventionally treated	Including insuficient treated	Watercourse 2	Watercourse 1	Watercourse 0	River bazin district
1	Basarabeasca	12.5	254.5	0.0	254.5			Cogilnic	Danube - Prut - Black Sea
2	Briceni	9.8	74.4	0.0	74.4		Lopatnic	Prut	
3	Cantemir	6.0	55.5	0.0	55.5		Tigheci	Prut	
4	Ciadir Lunga	22.7	116.6	0.0	116.6			Ialpug	
5	Cimislia	16.1	0.0	0.0	0.0			Cogilnic	
6	Comrat	23.3	479.3	0.0	479.3			Ialpug	
7	Edinet	20.2	341.9	205.5	136.4		Ciuhur	Prut	
8	Falesti	17.6	130.1	0.0	130.1		Isnovet	Prut	
9	Hincesti	16.8	188.2	188.2	0.0			Cogilnic	
10	leova	10.9	88.3	0.0	88.3			Prut	
11	Nisporeni	14.7	88.6	88.6	0.0		Nirnova	Prut	
12	Stefan Voda	8.7	83.9	0.0	83.9			Sarata	
13	Taraclia	15.0	78.2	0.0	78.2		Lunga	Ialpug	
14	Ungheni	38.0	863.9	0.0	863.9			Prut	
15	Vulcanesti	16.9	39.2	39.2	0.0			Cahul	
16	Cahul	40.7	715.8	715.8	0.0			Prut	
17	Ocnita	9.3	0.0	0.0	0.0	Cubolta	Ciuhur Raut	Prut Nistru	Nistru
18	Anenii Noi	11.7	110.0	0.0	110.0		Bic	Nistru	
19	Balti	143.3	7683.0	7683.0	0.0		Raut	Nistru	
20	Calarasi	16.1	136.5	0.0	136.5		Bic	Nistru	
21	Causeni	19.9	140.2	0.0	140.2		Botna	Nistru	
22	Chisinau	663.4	55910.9	55814.5	96.4		Bic	Nistru	
23	Ciorescu	5.5	81.7	0.0	81.7		Ichel	Nistru	
24	Cojusna	0.0	0.0	0.0	0.0		Bic	Nistru	
25	Cricova	8.4	161.3	0.0	161.3		Ichel	Nistru	
26	Criuleni	9.5	0.0	0.0	0.0			Nistru	
27	Dondiuseni	10.7	81.0	0.0	81.0		Raut	Nistru	
28	Drochia	20.3	173.0	173.0	0.0		Raut	Nistru	
29	Floresti	15.3	231.2	231.2	0.0		Raut	Nistru	
30	Orhei	33.3	719.1	0.0	719.1		Raut	Nistru	

(continued)

Table 1.3 (continued)

Nr	Wastewater source (town)	Population in 2010 (ths)	Biologically treated (thousand m^3)			Discharged into			
			Total	Conventionally treated	Including insuficient treated	Watercourse 2	Watercourse 1	Watercourse 0	River bazin district
31	Rezina	15.9	0.0	0.0	0.0			Nistru	
32	Riscani	14.4	86.7	0.0	86.7	Copaceanca	Raut	Nistru	
33	Singerei	15.3	93.4	0.0	93.4	CiuluculMare	Raut	Nistru	
34	Soldanesti	7.6	0.0	0.0	0.0		Ciorna	Nistru	
35	Soroca	37.2	0.0	0.0	0.0			Nistru	
36	Straseni	21.1	0.0	0.0	0.0		Bic	Nistru	
37	Telenesti	9.8	83.1	0.0	83.1	CiuluculMic	Reut	Nistru	

Source Association “Moldova Apa-Canal” for columns No. 4-8, 2011

However, only the wastewater treatment plants from major towns (e.g. Chisinau and Balti) have their own laboratory to conduct the monitoring of wastewater quality. Other wastewater treatment plants conduct investigations on a contractual basis at the laboratories of the district centers of public health and investigation centers of the State Ecological inspectorate.

The State Ecological Inspectorate is in charge of checking the compliance with the requirements for wastewater discharges set up in the authorization for the special use of water. The laboratory analysis of both discharges from treatment plants and the receiving waters are conducted by the environmental investigation centers of the State Ecological inspectorate placed in Balti, Chisinau and Cahul. For that purpose, the investigation centers establish annual sampling programs for wastewater quality for the monitoring of biochemical oxygen demand, suspended solids and ammonium (NH4) at 29 wastewater treatment plants.

1.4 Surface Water Monitoring

The following map (Fig. 1.1) shows the location and type of surface water level and flow measuring stations. The present network consists of 39 stations. Seven stations are on the River Prut, eight are on the River Dniester, one is on the Danube, and the others are on basins lying wholly within Moldova (including two within the area of Transnistria). All stations record water level, water temperature, and flow rate. Most stations also record the thickness of the ice. The Moldovan stations on the River Prut are maintained by the Moldovan Hydrometeorological Service, but the flow is gauged jointly with Romania. There is regular exchange of data. In the case of the Nistru, although some of the measuring sites are on the Transnistrian side of the river, the exchange of data is on a regular basis based on unofficial agreements with the Transnistrian Hydrometeorological Service. The earliest level data from Moldovan stations starts in 1920, and the earliest flow data are from 1949.

Five stations have been fitted with automatic level measurement and transmitting equipment. These use pressure transducers to measure water level and transmit level values by cable to a data logger. The data logger is able to store data for several months and, if so equipped, can transmit data in real-time. The sensor also measures water temperature. The logger is fitted with a SIM card and the data are transmitted via the mobile phone network. In addition to hydrological data the battery voltage is also transmitted. Data before 1993 are available on paper only. From 1993 to 2009, data were entered in digital format in a DOS program. Since 2009 data are in Excel format.

SHS made a monitoring of benthic invertebrate fauna and phytoplankton, but is now in the process of harmonizing sampling and assessments methods with the WFD requirements. Zooplankton has also been monitored for a long period, but this is not included among the WFD hydrobiological quality elements.

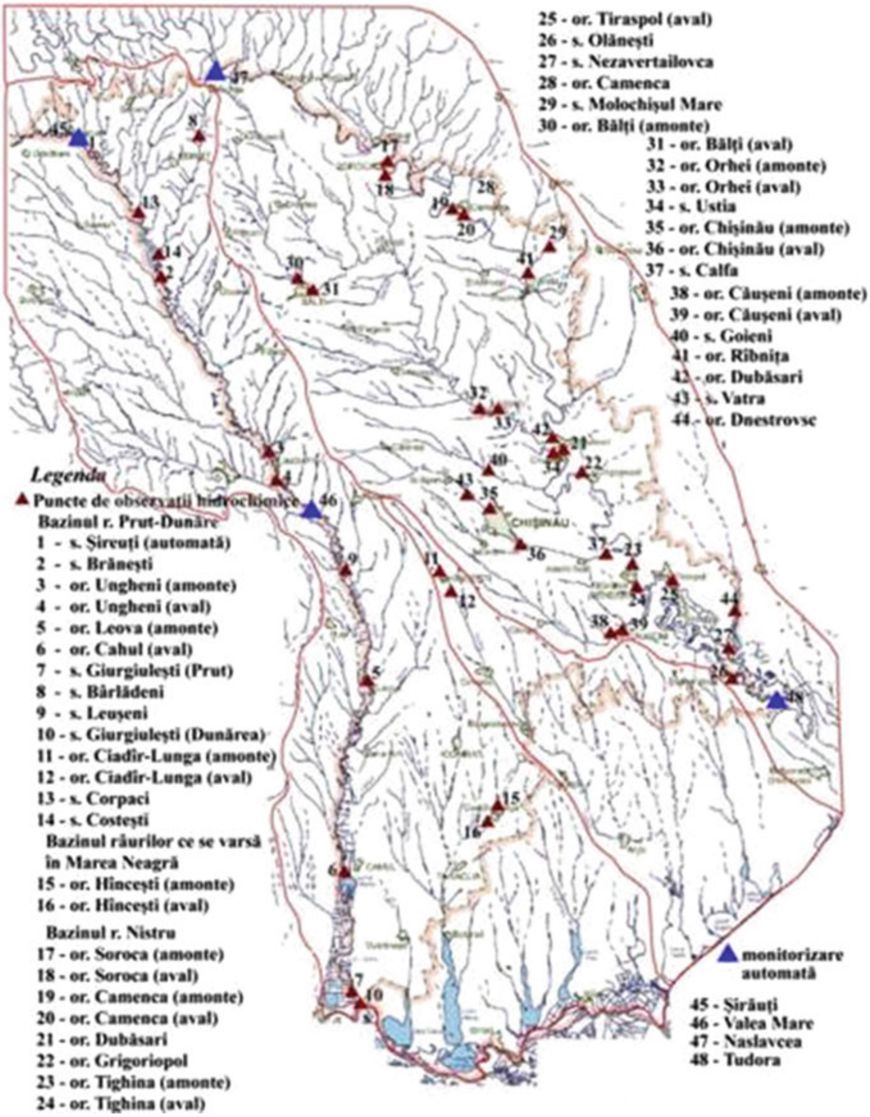

Fig. 1.1 Location and types of hydrologic station in Moldova (State Hydrometeorological Service)

Monitoring of phytobenthos is scheduled to substitute the traditional monitoring of periphyton; introduction of methods for sampling and assessment of phytobenthos, in line with the WFD requirements, is under development. Monitoring of macrophytes is envisaged but also not yet operational.

Special points of attention with monitoring and assessment of hydrobiological quality elements are "reference conditions" and the "ecological quality ratio".

Both terms originate from the WFD, but expected to become relevant for Moldova as well.

- *Reference conditions* are closely linked with WFD's 'high status', defined as the biological, chemical and morphological conditions associated with no or very low human pressure. This is also called the 'reference condition' as it is the best status achievable. Reference conditions are type-specific and region-specific, so they are different for different types of rivers, lakes or coastal waters so as to take into account the broad diversity of ecological regions in Europe.
- The *ecological quality ratio* is an expression of the relationship between the values of the biological parameters observed for a given body of surface water and the values for those parameters in the reference conditions. The ratio is expressed as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero.

Moldavian institutions are merely in the preliminary stages of starting to define reference conditions and ecological quality ratios for Moldovan surface waters.

1.5 Groundwater Monitoring

Groundwater status refers to both the quantity and chemical quality of groundwater. Groundwater levels are used as the main measure of quantitative status. To achieve good groundwater quantitative status, the available groundwater resource should not show signs of depletion and the ecological quality objectives for groundwater-dependent surface waters should be met. For this to occur, the long-term average rate of groundwater recharge should not be exceeded by long-term average rate of abstraction and maintenance of surface minimum flows. Groundwater abstraction must not also cause failure of good ecological status in dependent surface water bodies, such as damage of groundwater dependent terrestrial ecosystems, saline intrusion in coastal aquifers or upward migration of deep-seated brackish water.

Groundwater chemical status can be measured by determining the principal chemical composition and the concentration of pollutants in the groundwater body. This is usually done by reference to threshold concentrations and EU water quality standards, and the environmental objectives in associated surface waters or terrestrial ecosystems.

Moldova has multiple aquifer layers, composed predominantly of limestones and sandstones in the north and sands to the south, each with discretely different characteristics and different sources of recharge:

- A_3 Alluvial floodplain and terrace deposits
- N_2 p Pontian sands
- N_1S_3m Upper Sarmatian-Meotian aquifer group

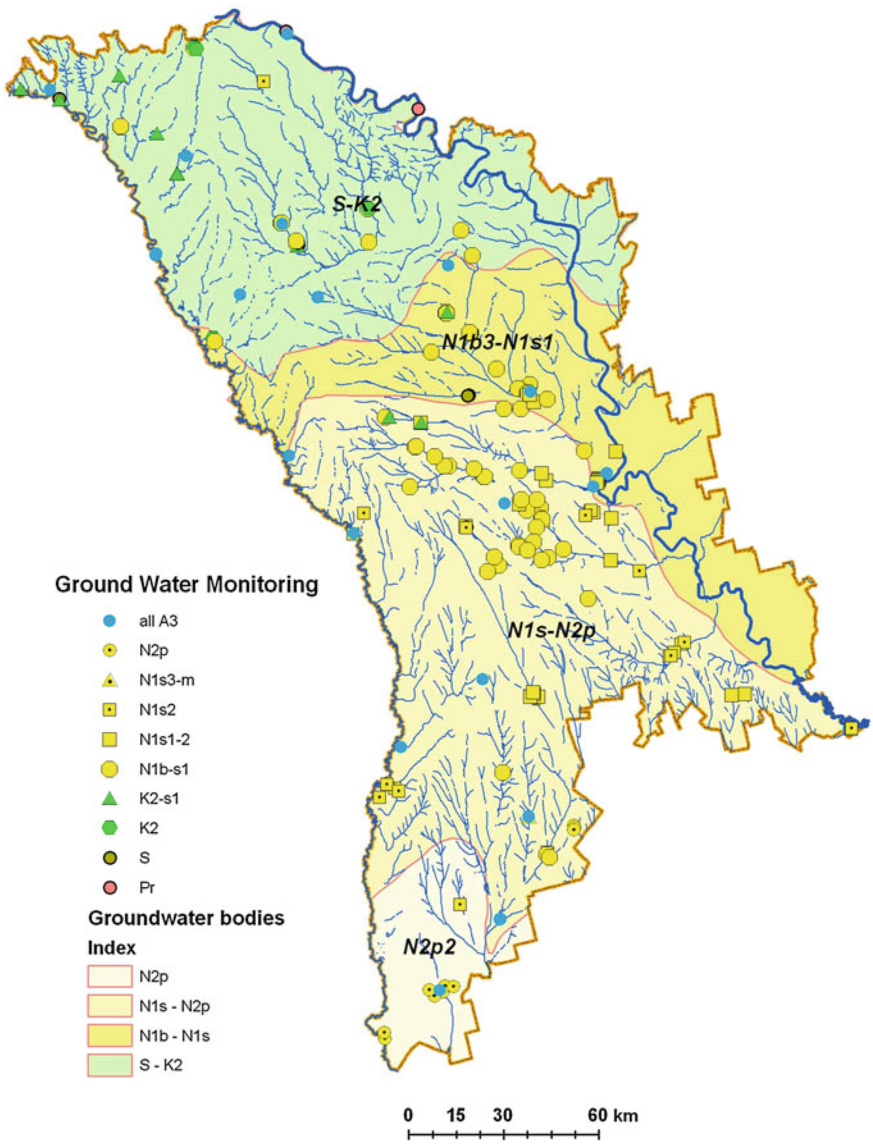

Fig. 1.2 Groundwater monitoring network in Moldova (*Source*: Five-Year Report: Investigation of Groundwater Regime and Balance Elements during 2005–2009, EHgeoM, 2010)

- N_1t – $N_1S_{1\text{-}2}$ Baden-Sarmatian aquifer group
- K Cretaceous karstic limestone
- S_1 Silurian crystalline limestone
- V Vendian crystalline basement rocks.

Some geological formations of the same age may be considered to give rise to different aquifer types in different parts of the country, as a result of lateral changes in lithology which cause the same formation to have different hydrogeological properties in different regions. Groundwater bodies can be identified from one or more of the main stratigraphic units, grouping together geological formations with similar properties and hydraulic parameters and which have both horizontal and vertical hydraulic continuity.

The existing set-up for groundwater resource assessment and monitoring throughout the territory of the Republic of Moldova was established in 1968. This monitoring network is shown in Fig. 1.2. The main aquifers used for water supply are monitored using a network of observation boreholes. The level of water in the boreholes is measured by observers and local residents. The measurements are then sent monthly by post to Chisinau. The correctness of measurements is checked during inspection visits, carried out by the EHgeoM, usually about twice a year.

Unfortunately, in recent years, the number of observation wells appears to have decreased, from 490 boreholes in 1991 to about 170 boreholes in 1997 and 186 in the 2010 report. At the last inventory [12], observations were carried out in 186 observation wells at 33 locations, and the level measurements were made once every 3 days. The instrumentation includes a Roulette WG-LM-30 and 50, level USAC-GL-150 - 200, thermometer TM - 10, and level measuring tools of made in Moldova by the EHgeoM. In the last decade, the frequency of sampling groundwater quality has decreased. Previously, in Soviet times, samples were taken from monitoring boreholes at least once a year, and more frequently in areas with complex hydrogeological conditions. Prior to sampling, water from boreholes was pumped out, following the guidelines established by VSEGINGEO (former Soviet Institute of Hydrogeology and Engineering Geology, Moscow). At present there are no funds for this kind of work.

Two type of groundwater quality analysis are made for there characteristics:

1. Routine sampling of major ions and physical characteristics: sodium, potassium, calcium, magnesium, ammonia, sulphite, sulphate, bicarbonate, chloride, nitrate, fluoride, methane, taste, odor, turbidity, color, dry residue, total hardness, carbonate and non-carbonate alkalinity.
2. Targeted sampling of micro-components when there is known to be a problem: phosphate, manganese, iron, copper, molybdenum, arsenic, lead, selenium, zinc, aluminum and beryllium.

During the last five-year EHgeoM reporting period of 2005–2009, there were 123 chemical analyses of major ions and physical parameters: just over half (i.e. 63) of these samples were collected from operational boreholes, 48 samples from observation boreholes, and 12 samples were collected from dug-wells. On average, this represents a monitoring rate of about 25 samples per year, which is extremely low. For example, in Western Europe, one public water supply source would have at least monthly sampling of raw water, and the sampling frequency would be increased if known pollution problems occurred in the aquifer. The current system in Moldova is therefore grossly inadequate in this respect, and such sampling does not provide effective management.

The analytical laboratory of EHgeoM is not accredited by ISO17025 and quality management of chemical analysis is not corresponds to appropriate normative documents. The obsolete equipment is used for chemical analysis: photocolorimeter MB-2 MB-56 m, Pressure Gauge EV-74 scales, laboratory balance VLA-200, weight F-2 – 210 [12].

The analysis of previous geological and international reports shown a number of water quality problems, they tend to be localized in nature. The main issues involve the following contaminants:

- Fluoride, ammonia, methane, nitrogen [related to oil and natural gas reserves];
- Hardness;
- Iron, Aluminium;
- Sulphates [potassium and sodium];
- Hydrogen sulphide;
- Nitrates [show rising trend at last years];
- Selenium, Strontium.

The electronic archive of groundwater data is compiled by the AGRM in EXEL format, but this work needs a more precise a borehole position. Unfortunately this information also is not exchanged with other stakeholders. EHgeoM produce annual and five-year reports. Apart from the Excel spreadsheet(s), no data are available electronically, and all drawing work is still done manually (no CAD or GIS in the 2010 report).

In addition to groundwater resource assessment, the inventory of boreholes should to be made for the database creation for further GIS modeling, groundwater body delineation and mapping of hydrogeological condition. Due to lack of funds, this work was suspended in 2002 [13]. It was noted in the EHgeoM 5-year report that there has been no progress with this activity [12]. As a result, it is estimated that about 30–40 % of the 7.000 boreholes are not working, and no effort will be made to decommission or backfill such sites. Consequently, such boreholes provide a potential pathway for surface pollutants to contaminate the aquifer.

1.6 Capacity of Analytical Laboratories

The potential of the analytical capacity of State Hydrometeorological Service (SHS) and other stakeholder laboratories (National Centre of Public Health, NCPH) is sufficient for the analysis of most of the physico-chemical parameters included in WFD and Water Law. The number of actually monitored parameters is considerably smaller; due to a combination of factors like lack of reference material and certification standards, specific equipment, and qualified personal.

Moldavian laboratories use a variety of normative documents for analysis of the various parameters, applying rather old standards developed during the Soviet era through recent ISO methods. The analysis' detection limit is not sufficient for some monitoring elements included water regulation documents for the protection of surface and ground waters. The detection limit is determined by a combination of the equipment, method and reagents used for the analysis. For example, the detection limits for aldrin, atrazin, HCH, para-para—DDT by the thin layer chromatography being less sensitive than gas chromatography.

The SHS and NCPH laboratories are accredited to ISO 17025. The lab makes use of Shewhart Control Charts and internal plus external reference material and samples. These laboratories takes part in the QUALCO Danube AQC Scheme, a basin-wide analytical quality control program in which some 35–50 laboratories participate. SHS and NCPH conduct joint sampling exercises with other Moldavian accredited laboratories, Ukraine (laboratories of the State Committee for Water Management in Novodnestrovsk and Odessa) and with Romania. EHgeoM laboratory is not accredited and no has quality management system.

1.7 Conclusions and Recommendation

The appropriate IWRM and IRBM can be realized on the basis of good organized decision making system. The creation of integrated GIS system which will include all information blocks is needed for the water management purposes. The following information should be included: water abstraction and discharge; pollution sources (diffusion and point); water treatment plants; water supply points; surface and groundwater bodies' delineation and characteristics; surface and groundwater monitoring network; water quality and quantity status of water bodies. The monitoring of abstraction and discharge is important for the assessment of water resource availability, management of resources, and collecting fees for water use.

There are a number of software packages which have been developed in developed countries specifically for handling a country's national archive of hydrological and meteorological data. They are all relatively similar, and all fit for purpose, and could easily be implemented in Moldova and linked to the proposed GIS platform. Ground water management is needed the realization of GIS system by the following principal actions:

1. Creation of geological and hydrogeological database as a base for geological GIS and decision making system;
2. Delimitation and characteristic of groundwater bodies for the principal aquifers which should be made in the frame of WFD requirements;
3. Digital mapping of different characteristic of groundwater bodies and aquifers which will include:

   - Distribution of monitoring, observation and production boreholes, and village wells with there characteristic;

- Distribution of the groundwater bodies, hydrogeological regions and principle aquifers, water supply points and other geological and hydrogeological objects;
- Groundwater body classification and quality status.

The groundwater body identification is important in wetland depending ecosystems for the management and the maintaining of the ecological quality of surface waters and terrestrial ecosystems, very often by supporting dry season river flows and wetlands. It is important also for the providing water for agricultural, industrial and domestic use.

The database and GIS systems will need to be used for risk analysis and environmental sustainability assessments later, and the systems will also need to be linked to the other main data-banks, specifically the groundwater licensing system (abstraction and discharge consents). The created hydrogeological GIS key point for whichever system is used is that it should be capable of professional time series hydrological data management using a Relational Database Client–Server platform such as Oracle. It should be capable of operating within the GIS platform and support automatic remote data acquisition from field data loggers, with versatile data import and export tools. The software should be capable of handling meteorological, surface and groundwater components of the hydrological cycle, with a sophisticated graphical data editor and generation of tabular summaries such as yearbook-style reports.

The implementation of GIS system in Moldavian conditions will possible only in the cooperation between all stakeholders with the attraction of the qualified personal from other institutions like universities and Academy of Science. The scientific support of this work is very important because deficiency of qualified specialist is a one of the critical point in this work.

The implementation of modern chemical and physical sensors is a perspective approach for distance monitoring of water quality and quantity. It is important for the obtaining of the digital actual information about the status of surface and ground waters. The scientific support of this activity is needed at all stages from the installation, data transmission, processing and storage in the database.

The analytical capabilities should be improved by the implementation of modern analytical equipment and methods as well as quality management system in all laboratories which participate in monitoring program in Moldova. The participation in the interlaboratory exercises by the international schemes and in local program is an important part of this activity. the organization of local interlaboratory exercises can be executed in scientific laboratories from Academy of Science.

References

1. Starea Mediului în Republica Moldova în 2007–2010. (2011) Raport Naţional. Ministerul mediului al Republicii Moldova, Academia de Ştiinţa a Moldovei, Institutul de Ecologie şi Geografie, 192 p
2. Irrigation Sector Reform Activity (ISRA) River Basin Management (RBM) Sub-activity Institutional and Monitoring Framework Report. Deliverable 7 Millennium Challenge Account Moldova Ref. project 278168. Euroconsult Mott MacDonald in association with: ACDI/VOCA, ACSA, Agland, Milieu, NGO BIOS, http://www.acdivoca.org/site/ID/ourwork_moldova
3. Dniester GIS - information management system and infrastructures for the transboundary Dniester river basin implemented during 2008–2009 with the support unep/grid-arendal, established a spatial/gis database for the Dniester river basin available at the following link: http://enrin.Grida.No/dniester/
4. Surface Water Monitoring and Flood Prevention in the river Raut (2006–2008) The Moldo-Czech project in the frame of the Czech Republic Assistance Programme http://www.meteo.md/moldceh2011en.htm
5. Monitoring of surface water and protection against flood in the Prut river basin. (under implementation 2010–2012) Project with the financial support of the Czech government. http://www.meteo.md/mold/monitorprutro.htm
6. World Bank Disaster and Climate Risk Management Project, 2010–2014, http://www.thegef.org/gef/sites/thegef.org/files/documents/document/Moldova%204630-webdoc.pdf
7. Reducing vulnerability to extreme floods and climate change in the Dniester river basin project. Organization for Security and Cooperation in Europe (OSCE), UN Economic Commission for Europe (UNECE) and UNEP, http://www.solutionsforwater.org/solutions/reducing-vulnerability-to-extreme-floods-and-climate-change-in-the-transboundary-dniester-basin
8. Transboundary cooperation and sustainable management in the Dniester River basin: Phase III - Implementation of the Action Programme (Dniester-III). OSCE, UNECE and UNEP with the support of the Swedish and Finnish governments, www.dniester.org
9. UNDP Moldova projects “Support for Environmental Protection” and “Transitional Capacity Support for the Public Administration of Moldova” http://www.undp.md/projects/SEP.shtml, http://www.undp.md/projects/PAS.shtml
10. NATO SfP Nr. 971918 SfP-Nistru/Prut. Real Time Monitoring and Decision Support Systems for International Rivers: Application to the Nistru and Prut Rivers. http://www.mfa.gov.md/nato-en/projects-moldova/
11. Opopol N (2006) Water management in Republic of Moldova. In: Dura G et al. (eds) Principal threats management of international and accidental water pollution, Springer, pp 167–176
12. Scerbacova VN, Jeleapov VI (2010) The study of the groundwater regime and balance, the state registry and maintanence of State Water Cadastre. In: Republic of Moldova, 2005 - 2009, Report of State Enterprise Hydrogeological Expedition of Moldova “EHGeoM”, fond AGRM nr. 3775
13. Ilinschii Iu F et al (2003) The inventory of operation boreholes on the territory of Republic of Moldova. I-th period: districts Leovo, Cimislia, Cainari, Causeni, Stefan Voda, Hincesti, Report of State Enterprise Hydrogeological Expedition of Moldova “EHGeoM”, fond AGRM nr. 3621