WATER RESOURCES IN ROMANIA DURING 1990-2018

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Abstract: *This paper presents the water management during 1990-2018 in Romania, all through the transition and free market economy period. It follows the institutional structure, investments, water management and consumption, water quality all around Romania. The modernization of legislation and institutions after Romania joined the EU are specific for this period. On the other hand, water supply for population and sewage network received significant funds from EU. Conservation measures were taken as renaturation of Danube and improving fish migration. Excessive building of micro-hydro plants damaged the good status of mountain rivers.*

Keywords: *water resources, water management, dam, sewage, water supply*

JEL Classification: *A10, H54, P28*

INTRODUCTION

This paper examines the evolution of water resources in Romania, during the period 1990-2018.

From a water resources perspective, 1990-2018 period was an important one because institutions and legislative measures that were taken allowed the modernization of the sector as well as improvement of water management and utilisation of water resources.

Romania's water resources - reserve and structure

Romania's water resources are composed of surface waters (rivers, lakes, the Danube River) and groundwater.

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The potential and technically usable water resources are presented in Table no.1. The theoretical water resource, in Romania, in 2017, was of 134.6 billion cubic meters / year (it refers to surface waters - rivers, lakes and Danube river - and groundwater), out of which the water resource, according to the river basin management, is about 40 billion cubic meters (cm) / year. Danube resources are about 85 billion cm/year and that of underground water is 9.6 billion m (see Table 1). Therefore, out of a total resource of 134.6 billion cm only 38.46 billion cm are usable under current arrangement (28.5%).

Table 1. Water resources in Romania (2017)

Water source/Characteristic Indicator	Total thou mc
A. Inland rivers	
1. Theoretical resource	40,000,000
2. Existing resource according to the degree of river basin management *	13,679,121
3. Requirement of water for use, according to capacities in operation	2,965,116
B. Danube (Direct)	
1. Theoretical resource (in section when entering the country)**	85,000,000
2. Resource usable under current arrangement	20,000,000
3. Water demand for uses according to capacities in operation ***	3,164,721
C. Underground	
1. Theoretical resource, out of which:	9,600,000
- groundwater	4,700,000
- deep water resource	4,900,000
2. Usable resource	4,667,639
3. Water demand for uses according to capacities in operation	716,503
D. Black Sea	
- Water demand for uses according to capacities in operation	10,243
Total Resources	
1. Theoretical resource	**134,600,000**
2. Resource usable under current arrangement	**38,346,760**
3. Water demand for uses according to capacities in operation	**6,856,585**

Source: Synthesis of water quality in Romania in 2015 (extras), ANAR, 2016.

Note: * It also includes the network of coastal lakes as well as the resource provided by direct external reuse along the river; ** ½ of the multiannual average stock on entry into the country; *** including volumes transferred to the Seaside basin.

The main water resources of Romania are the inner rivers (78,905 km of rivers) and Danube river. A basic feature of this resource category is the variability determined by:

- Streams from mountain area, which brings half of the leaked volume;
- Streams with significant variation of the average flow rate (1 l / s and km^2 in low areas, up to 40 l / s and km^2 in high areas);

- Fluctuating evolution over time, so that in the spring there are important floods, followed by prolonged droughts. At national level, 39.7% of the total annual leakage occurs in the spring, 14.2% in the autumn (the driest season), 26.7% in the summer and 19.4% in the winter.

The country`s territory can be divided into three large areas with different climatic types, namely the western, eastern and southern regions. Romania's water resources are also unevenly distributed in space: rich outflow is only happening in the west region, 1.36 times higher than the country's multiannual average.

The river basins with high resources of surface water are relatively small and situated at high altitudes: Nera - Cerna and upper Tisa, followed by Jiu, Olt and Somes. The poorest in water resources is the Seaside basin.

The estimate for water resources took into account exogenous[1] rivers as Danube and the watercourses in the Upper Siret basin - which amounts 170 km³ / year. Under these circumstances, it can be said that Romania depends to a large extent on the water resources coming from different upstream countries. These water resources are not entirely usable. Therefore, unlike the countries of Western and Northern Europe, the lack of sufficient water resources is likely to become a limiting factor of economic development unless an intelligent policy of rational water use is promoted.

Romania`s lakes

Romania has around 3,500 lakes, but only 1% of them have an area exceeding 1 (one) square km. More important are the lagoons and the Black Sea coastal lakes (Razim 41,500 ha, Sinoie 17,150 ha) and the lakes along the Danube bank (Brates 2,111 ha, Bistret 1,867 ha). Glacial lakes are mostly spread in the Carpathian Mountains (Bucura is the largest of them, 10.5 ha).

Water regime and legislation, after 1990

After the end of command economy, we should mention the important change in the status of the waters (rivers, lakes, underground waters, marine waters). Therefore, according with the 1996 Water Law[2], waters are no longer owned by the whole people but are public goods. It could be noted that water resources regime, as public goods was similar with the status held by waters after the Great Union of Romania, in 1918. Later on, Water Law was amended and reformed many ways. One of the most

[1] This represents the contribution of the rivers that form on the territory of other countries and then enter the territory of Romania

[2] Source: CAPITOLUL I, Dispoziții generale, Art. 1., Legea Apelor (nr.107) din anul 1996.

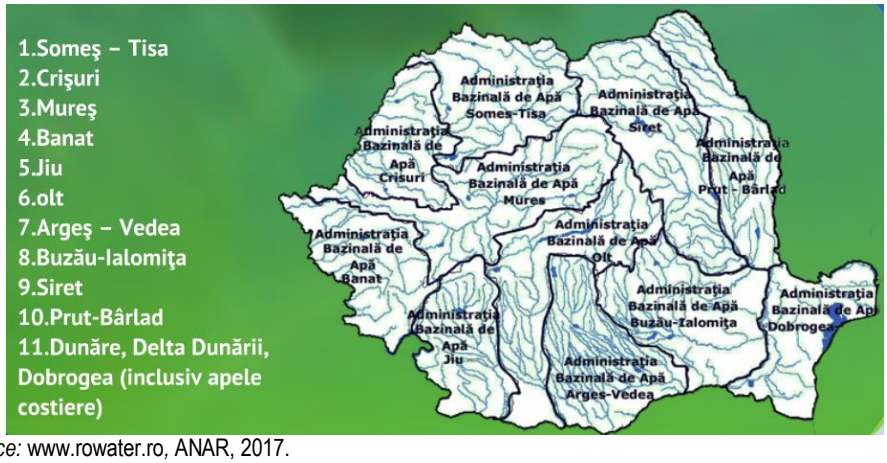
important reform was when Romania transposed EU legislation in the field of waters. The completely environmental acquis was transposed before 2007 when Romania became member of the EU. New elements such as the objective of achieving good status of surface and underground waters, water ecosystems and ecosystems that are predominantly dependent on water, organizing on hydrographic basins (11 hydrographic basins), etc., should be mentioned.

Of particular importance is the Water Framework Directive, whose main purpose is to achieve the "*good status*" of all bodies of water in natural conditions. Also, the Drinking Water Directive and the Urban Waste Water Treatment Directive 91/271 / EEC transposed into national law by H.G. no. 188/2002, amended and supplemented, which requires that all agglomerations with more than 10,000 inhabitants equivalent have to be provided with sewerage networks by 31 December 2013 and until 31 December 2018 all agglomerations between 2000 and 10,000 equivalent inhabitants to own such sewerage and treatment plants.

From the administrative point of view, the waters in Romania are managed[1] by the National Administration "Apele Române" Bucharest, a public institution of national interest, with legal personality, functioning based on economic management and autonomy.

Numerous successive organizations have been registered from 12 Water Directorates to 12 territorial branches. So far, by amending and completing the Water Law no. 107/1996, there are in function 11 Water Basin Administrations (next Figure). All water programming and management is done at the basin level, as is the case in all EU Member States.

Figure 1. Romanian water basins



Source: www.rowater.ro, ANAR, 2017.

[1] Legea nr. 404/2003./Law no. 404/2003

By transposing the acquis communautaire in the water domain, Romania has the same legislation as that existing in all EU member states. This stage of institutional and legislative modernization was unprecedented in Romania's history. It should be said that at the time of accession (2007), Romania assumed very ambitious objectives in the field of water, which subsequently proved difficult or impossible to meet the assumed deadlines.

Water consumption

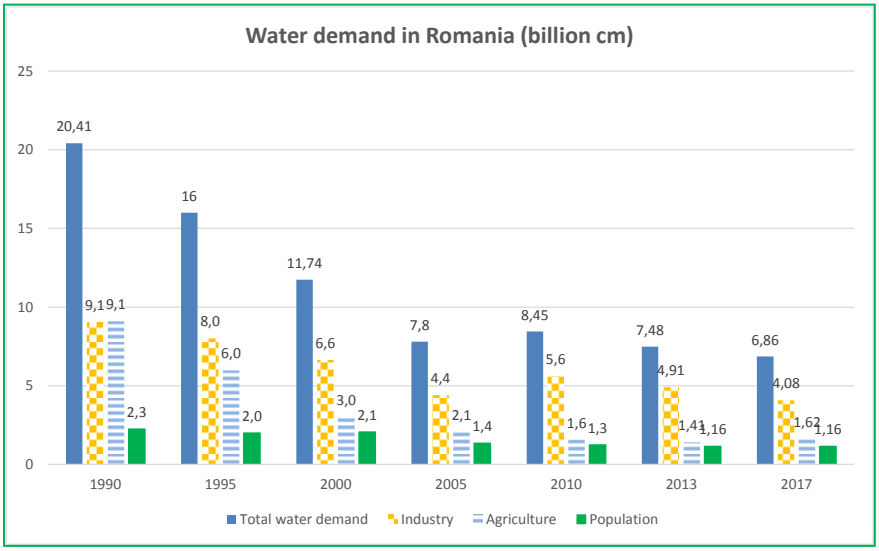
After 1990, water consumption has dropped drastically in Romania. At the level of 2017, the Romanian water requirement decreased by 13.55 billion cubic meters of water compared to 1990, from 20.5 billion cubic meters of water (as it was in 1990) to 6.86 billion cubic meters of water (as it was recorded in 2017).

Compared to 1990 level, there have been dramatic drop in water demand for all categories of consumers (industry, agriculture and population). Water demand diminished continuously from 20.4 billion cubic meters, as it was in the year 1990, to 6.86 billion cubic meters of water, as it was in 2017 (Figure 2). That means a drop of 13.55 billion cubic meters in 27 years (an average of 0.5 billion cubic meters /year). By category of users, the water requirement for industry was reduced by more than half, from 9.06 billion cubic meters of water, as in 1990 to 4.08 billion cubic meters of water, registered in 2017. This evolution was due to the decrease in the volume of industrial activities, the reduction of the specific water consumption, the application of the economic water management mechanism, etc.

Reducing the water demand for agriculture has been severe, depending on the evolution of the hydrological regime and has also been influenced by the irrigation capacities still in operation. During the analysed period (1990-2017), the amount of water consumed by agriculture decreased many times (from 9.1 billion cubic meters to 1.16 billion cubic meters) (close to population consumption). The explanations are multiple: the lack of water in the irrigation systems, the destruction of existing irrigation systems, the fragmentation of agricultural properties, the impossibility of farmers to pay for the water supplied, etc.

The water requirement for the population was relatively constant but declining continuously, in absolute terms, over the entire 27-year period (Figure 2). This reduction occurred despite the expansion of water supply networks. Network modernization has reduced water losses in distribution pipes, increased metering took place and tariffs close to cost recovery have been applied. All these measures have contributed to reducing specific consumption and eliminating water losses.

Figure 2. Water demand in Romania



Source: Sinteza calității apelor din România în anul 2017 (extras), ANAR

Infrastructure and investments

After 1990, the volume of investments in water management decreased sharply compared to the command economy. No major independent water management work has been done, but only maintenance and repair of existing ones and completing objectives under construction.

In this context, it should be noted that during the period 2000-2017, Romania received a non-reimbursable aid, almost € 2.5 billion funding from the EU through the pre-accession instruments (ISPA, SAPARD and PHARE) and structural funds. With the help of these funds, measures have been taken in order to achieve the objectives of the acquis communautaire in the water domain[1], which were also included in the Accession Treaty of Romania to the EU and requested by Water Directives transposed by Romania. The main investments supported by the EU were in the field of expansion and modernization of water supply and sewerage, flood protection and biodiversity conservation.

[1] Initial terms were not fulfilled so far (2018). For instance, in 2015, the deadline for the Water Framework Directive was postponed to 2020. So also for Directive 98/83 / EC on the quality of water intended for consumption.

In 2017, Romania's existing water management infrastructure consisted of 11,510 km of dikes, 12,667 km of regularization works, 8341 km of shore defenses, 1,100 km of canals, 2420 accumulations, and 324 permanent accumulation lakes (Table below).

Table 2. Water infrastructure in Romania (2017)

Infrastructure	Value
Dams	11510 km
Water works	126667 km
Defense shore works	8341 km
Canals	1100 km
Natural lakes	409 (pieces)
Water accumulations/volume	2420 pieces/14.2 billion cubic meters
Permanent accumulation lakes	324 (pieces)

Source: www.rowater.ro, ANAR, 2017.

As a result of the EU aid (ISPA, SAPARD, PHARE, the Environment Operational Program (2007-2013, 2014-2020) etc.) and the efforts made by the national authorities, the water supply network increased by 2,67 times, from 27,795 km (in 1990) to 74,263 km (in 2014[1]) and the number of localities receiving drinking water increased to 2,447 of which 317 cities. With regard to the sewerage network, between 1990 and 2015, the network doubled from 13,627 km in 1990 to 28,659.5 km in 2014. The number of communes with sewerage network[2] reached 1071 (out of 2861 communes) and 311 cities (out of 320 cities). From these data, 63% of the total number of communes still do not have sewerage and nine newly declared cities[3] are in the same situation.

Water pollution, biodiversity

After 1990, the issue of water pollution began to be discussed, especially since the year 2000 when Romania start preparation for EU accession. Generally, because of the drastic decline in industrial activities and the decrease in the use of chemical fertilizers

[1] Source: Anuarul Statistic al României 2015, Rețeaua şi volumul apei potabile distribuite, INS, Bucureşti, 2016.

[2] Source: Anuarul Statistic al României 2015, *Canalizare publică şi spații verzi* (la sfârşitul anului), INS, Bucureşti, 2016.

[3] This is inconsistent with the law of declaring cities and communes that imposes a certain level of infrastructure and utilities for a commune to be declared a city.

in agriculture, industrial pollution and agriculture pollution have diminished. Intensive agriculture practiced by Romania in the past remains one of the causes of diffuse pollution. In the Romanian Plain and in the Western Plain, especially in groundwater, higher nitrate concentrations are recorded, one of the main causes being the incorrect use of chemical and organic fertilizers and incorrect storing of manure.

The major pollution problems are recorded in downstream sections of large urban agglomerations that do not have wastewater treatment plants or do not have purification plants. An example is the Municipality of Bucharest, which alters[1] the quality of the Dâmbovița and the Argeş River downstream. At present, the Bucharest wastewater treatment plant is not fully in function and it is not clear when it will be operational. With regard to groundwater, the biggest problems are encountered in the main industrial platforms: Savinesti Platform, Azomures, PetroBrazi, Doljchim, Oltchim, etc.

For instance, from the point of view of the length of water bodies (rivers) evaluated and monitored[2] in 2017, 3404.59 km were distributed as follows:

- 904.30 km (26.56%) of good ecological status;
- 2488.47 km (73.09%) in moderate ecological status;
- 11.82 km (0.35%) in bad ecological condition.

As regarding accidental pollution, in the late period (2012-2017) were recorded 50-70 pollution accidents/year (Annex 1). Most pollution accidents took place in Mureş Basin (67 accidents), Arges-Vedea basin (61 accidents), Olt basin (43 accidents).

As a novelty over previous periods, it has to be mentioned that the issue of biodiversity protection and conservation of water resources has begun to be raised and taken into account, especially after EU accession. Among the many aspects of biodiversity and the protection of water resources, we can mention several of them:

1. **Ladders for fish migration**. In the command economy, many dams with different functions have been built across rivers (mainly for power generation). These dams have fragmented the watercourses, making it impossible for fishes (trout, sturgeon, etc.) to migrate upstream. Therefore, it was created a great problem of perpetuation of fish species. At present, all 11 plans for basin planning provide for fish ladders and threshold investments to facilitate fish migration. In the case of the Somes-Tisza River Basin Action Plan, seven fish ladders will be provided.

[1] The Bucharest wastewater treatment plant is only partially functional.
[2] Source: Sinteza calității apelor din România., în anul 2017 (extras)., ANAR

2. **Renewal of the Danube meadow**. The rehabilitation of the hydrological system and the restoration of habitats and ecosystems in the Danube meadow are two of the main objectives of the restoration program developed for the Danube river. One of the successful actions was the rebuilding of the 29,000-hectare Greaca[1] agricultural area (Gostinu - Prundu - Greaca). It should be noted that this once wet area was also mentioned in the Encyclopedia of Romania in 1938 as a wet area that had to be preserved but which, however, later on, was dammed and dried. Prior to damming of the zone, the floodplain area consisted of large, permanent ponds, ridges and reedbeds, smaller ponds (often dry in the summer), slightly flooded lowlands, higher terrain flooded only when the waters was crossing the banks and high beams that flooded only at extraordinary high tides. It should be noted that the process of redevelopment (ecological reconstruction) is difficult and long-lasting, involving the flooding of areas protected by dykes and the relocation of settlements, the abandonment of agricultural practices, etc.
3. **Micro-hydro.** Since 2007, the focus has been on the development of micro-hydro power plants in Romania. As a result of a very high subsidy, the dynamics of renewable energy production has seen rhythms of growth not seen in other EU Member States. Thus, in 2004, the share of renewable energy in Romania was about 17% of the total and the production was almost entirely due to the hydroelectric system built between 1960 and 1990. Following the implementation of the package of measures to achieve renewable energy targets for 2020, the production of renewable electricity, supplied by hydro, solar, wind, biogas, etc. jumped from 17% (in 2004) to 24.6% (in 2014) of total gross energy consumption, exceeding the 24% target proposed by the EU for 2020. This surprising situation, to reach a proposed European target six years earlier[2], is due, on the one hand, to the high share of already existing hydro plants (17% of the total) and, on the other hand, to the extremely high subsidy, without economic justification, granted to renewable energy types: wind, solar, micro-hydropower, biomass that covers only 7% of the total.

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[1] The data collected by Grigore Antipa (important Romanian naturalist) around 1910 show that, at that time, Greaca ecosystem was predominantly made up of aquatic ecosystems, natural meadows, forests and wetlands. At that time, the Greaca area provided very diversified goods and services, from recreation and regulation of the Danube's flow to floods of fish, reed, rush and wood..

[2] This situation that Romania to reach a EU goal six year before the deadline was never recorded.

In this context, more than 500 micro-hydroelectric plants, whose electricity production is less than 2% of the total electricity produced in Romania, are functioning.

According to World Wild Found estimates[1] in Romania, micro-hydropower plants have profoundly harmful effects (5 to 8-fold) on the aquatic natural environment, relative to the unit of energy produced (specific effect, per kWh produced) compared to medium or large hydropower plants. Thus, from the point of view of the surface of impact, the affected river area is extremely high: about 200 m of affected river for one GWh per year, for small plants, compared to "only" 17 m per GWh per year, in the case of large power plants with storage lakes. Basically, whole rivers are diverted through underground pipelines completely ridding riverbeds and destroying entire aquatic habitats across the entire length of the mounting river in question.

Such overexploitation of mountain rivers is possible because there are neither mandatory criteria for regulating the construction of micro-hydropower plants nor plans at a regional, regional or national level to restrict the overdevelopment. As a result of the excessively large subsidy granted through green certificates, the development of micro-power projects has taken an unprecedented scale in Romania. What is most revolting is that micro-hydropower plants are being promoted as a contribution to reducing greenhouse gas emissions. In fact, greenhouse emissions reduction is negligible and the price paid is the loss of vegetal and aquatic biodiversity on mountain rivers.

Conclusions

Between 1990 and 2017, the water resources are again part of the public domain of the state, as a natural heritage that must be protected, treated and defended as such. Water legislation is in line with modern European legislation; the acquis communautaire was transposed in its entirety. Water resources are managed by a national company organized on 11 river basins. Investments in that period are small, without big works; more consistent investment in water supply and sanitation is achieved with massive support from the EU. No new hydropower developments were made, but existing ones were upgraded and modernized.

Water consumption has fallen below seven billion cubic meters / year compared to 20 billion cubic meters / year in 1990. At present, all cities and municipalities have water and sewerage and specific water consumption has dropped a lot (about 120 l/pers/day). An economic approach to agricultural irrigation is also being attempted.

[1] Şapte (7) Mituri Despre Hidroenergie. Adevărul despre impactul hidrocentralelor asupra naturii şi comunităților locale, octombrie 2013. http://www.wwf.ro/resurse/ publicatii/7_mituri_despre_hidroenergie/

There were no more large-scale works for embankments. It comes back to the idea of renaturation of the Danube meadow as a mean of preventing floods. Restoration of fish migration routes is also starting, but the deterioration of mountain water bodies is highlighted by the excessive construction of micro-hydropower plants.

The following table summarizes the main features of the domain, between 1990-2018.

Sub-domains	Features of the period 1990-2018
Juridical Status	Waters are public goods, a natural heritage that must be protected, treated and defended as such
Legislation	Water laws and EU acquis transposed into Romanian legislation; frequent changes in the legislation and administrative structure
Institutions	Ministry, Romanian Administration for waters, 11 water basins
Investments	Small-scale investments for water management; significant investment in water supply and sewage; significant EU financial aid
Water consumption	Water consumption reaches lowest value in 2017 (6.86 billion cm) compared with 20 billion cubic meters recorded in 1990.
Water supply	The number of localities receiving drinking water increased to 2,447 of which 317 cities. Decreasing water consumption (approx. 120 l/person/day compared with 350-400 l/person/day before 1990); losses reduction and expanding metering.
Irrigations	Significant decrease of water demand up to 1,62 billion cm (in 2017) from 9.1 billion cm (in 1990).
Industry	Most of the hydro potential was reached before 1990. Low scale water works
Flood protection	Maintenance of flood protection works, drainage, coastal erosion protection, etc.
Ecology, pollution	Persistent historical industrial and agricultural pollution, improving fish migration, renaturation of Danube meadows, and deterioration of mountain water bodies due to the excessive construction of micro-hydropower plants.

ANNEXES

Annex 1. Accidental pollution in Romania (2012-2017)

Water basin	2012	2013	2014	2015	2016	2017	Total
Someş - Tisa	7	5	5	6	4	3	30
Crişuri	1	0	0	2	2	1	6
Mureş	10	8	4	9	10	26	67
Banat	0	1	0	0	1	1	3
Jiu	5	3	2	3	2	3	18
Olt	7	10	6	10	6	4	43
Argeş - Vedea	7	11	14	13	9	7	61
Buzău - Ialomița	3	8	8	4	7	2	32
Siret	10	8	1	9	2	10	40
Prut - Bărlad	11	4	5	3	4	9	36
Dobrogea - Litoral	4	4	11	4	2	4	29
Total	**65**	**62**	**56**	**63**	**49**	**70**	**365**

Source: Sinteza calității apelor din România, în anul 2017 (extras)., ANAR

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