SURFACE WATER MANAGEMENT FROM BÂRLAD WATERSHED

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"Craving for water" of the humanity or perspective of "water crises" is term, which appear more frequently in prognosis studies of different international and national organisms.

In our country areas, which are in difficulty with surface and underground water sources, by the INMH study, are located in central part of Dobrogea and Moldavian Tableland and us a result these resources must be careful utilised and protected quantitative and qualitative.

Hydrographical network of Barlad River with 2,565 km length and 7,220 km^2 drain the Central Moldavia Tableland and Tutova Hill's area through Barlad River and their most important affluent

The Central Moldavia Tableland and Tutova Hills, like subdivision of Moldavian Tableland, drained by Barlad River are strongly affected by erosion processes that have a great impact under the quantitative and qualitative surface water from this area.

The management of surface water from Barlad watershed are assured by Vaslui Water Management System, like a subdivision of Water Direction Prut from Romanian Environment Minister.

Soil Erosion Control Research and Development Centre Perieni are involved in surface water management from Barlad watershed through a study concerning hill lake sedimentation's and water quality of them under impact of soil erosion processes.

In the studied reservoirs, sedimentation processes are due to the deposit of sediments from the main water supply of the reservoir and of those that are due from erosion from hill slopes and watersheds located nearby of the reservoir.

Degradation of water quality is mainly due to decreasing of water depth and natural adding of fertilises elements.

Regarding sedimentation of Cuibul Vulturilor reservoir it comes out that:

Rate of sedimentation reservoir was of 32.63 % with 2.33% average ratio by year:

Sedimentation ratio by year is of 221,430-cm. in comparison with 10,000 cm. who was anticipated in 1977;

The bigger sediment effluence provide from the small watersheds who are directly coming into the reservoir (7.93–9.87 to/hectares from the direct slopes and 1.8–30.5 to/ha from these kind of little watersheds.

Regarding water quality degradation of Cuibul Vulturilor reservoir it comes out that:

In June, when the level of precipitation is higher, the value of nitrogen, phosphorus and potassium concentration is also higher;

The higher concentration value of studied elements are recorded on the laterally inputs;

The comparative analyze of tow situation watershed with erosion control works and same watershed without erosion control works, set of some conclusions:

The erosion are reduced under acceptable limits (17.2 m^3/ha without erosion control works relative to 3.9 m^3/ha with erosion control works);

A proper cultivation structure mixed with erosion crop system reduced erosion and sediment effluence with 20%;

A good erosion control works capitalized efficiently rainfall, surface runoff are reduced with 11-30%;

An adequate reclamation of outlet network reduces gully erosion with 60%;

Ensemble of land reclamation (cultivation structure, erosion crop system, erosion control works on outlet network) reduces erosion and sediment effluence with 23%

Keywords: soil erosion, reservoirs, sedimentation, water quality.

"Craving for water" of the humanity or perspective of "water crises" is term, which appear more frequently in prognosis studies of different international and national organisms, the causes of these situations are included in characteristics of waters like natural resources.

Theoretical potential of water resources for Romania are appreciate for means year, from Meteorology and Hydrology National Institute Bucharest, to 103.4 billions cube meters, from who utilisable from technique and economic point of view are 41.5 billions cube meters / year. The same National Institute specified also the repartition of these from availability sources of Romania – from Danube River 53.2 billions cube meters; from inner rivers 39.6 billions cube meters; from natural reservoirs 1.0 billions cube meters; from underground sources 9.6 billions cube meters

The less value of water resources utilisable from technique and economic point of view are determinate from:

- specific nature of Romanian inner rivers, from their potential it could be utilise, in natural system, only 5.0 billions cube meters and from realised reservoirs still 11.0 billions cube meters;

- the situation of Danube River like a boundary and international navigable river and their geographical position compared to Romanian territory, utilised may be an water volume from 20.0 billions cube meters;

- reduced volume of natural reservoirs, their volume covered only evaporation and same

insignificant local consumptions;

     - in present from underground water utilised are 5.5 billions cube meters.

    The inner rivers of Romania have a particular nature:

     - a different rate of annual volume carry from watershed, most riche are their from Someş-Tisa, Olt-Vedea, Mureş and Siret watershed and their most pure are the hydrographical area central part of Dobrogea and Prut-Barlad.

     - variation of the flow not only from a season to another season but from a year to another year. For example the account between maxim flow and mean annual flow have a great variation from an watershed to another (12.5 from Mures, 27.0 from Somes, 79.0 from Buzau and from their placed in pore area these account is 100.0 or 1000.0 to the river with watershed less then 1000 square kilometres.

From underground water sources 4.0 billion cube meters /year are provided by surface water bearing stratum (the depth of exploitable water bearing is situated under 50 m), and 5,0 billion cube meters/year provided by big depth water bearing stratum (the depth of exploitable water bearing more then 50 m).

In our country areas, which are in difficulty with surface and underground water sources, by the INMH study, are located in central part of Dobrogea and Moldavian Tableland and us a result these resources must be careful utilised and protected quantitative and qualitative.

These study also making the fact that through realise reservoirs on inner rivers their utilisable potential are growing with 11.0 billion cube meters , growing are from 30 % in percent (from 12.6 % to 40,4 %).

On inner Romanian rivers until 2000 where realised more then 1130 hill lakes. These reservoirs have only one use or more using. The use structure, in percent, of using reservoirs it is (figure number 1):

-   24.7% only for fish breeding;
-   14,0% only for irrigation;
-   0.4% only for high flood attenuated or flood forestalls
-   0.9% for water supply in village area;
-   60.0% for more using.

These hill lakes have an about 3,500 billions cube meters maximum utilisable volume of water. The maximum utilisable volume of water has a following percent distribution (figure number 2):

  2.9% with water volume less then 10,000 cube metres;

18.7% with water volume from 10,000 to 50,000 cube metres;

12.6% with water volume from 50,000 to 100,000 cube metres;

20.6% with water volume from 100,000 to 200,000 cube metres;

29.2% with water volume from 200,000 to 500,000 cube metres;

  9.7% with water volume from 500,000 to 1,000,000 cube metres;

  3.6% with water volume from 1,000,000 to 2,500,000 cube metres;

  2.7% with water volume more then 2,500,000 cube metres;

Hydrographical network of Barlad river with 2,565 km length and 7,220 km^2 drain the Central Moldavia Tableland and Tutova Hill's area through Barlad river and their most important affluent: Tutova, Pereschiv, Berheci, Zeletin and Simila rivers from Tutova Hills and Racova, Vasluet and Crasna from Central Moldavia Tableland.

The Central Moldavia Tableland and Tutova Hills, like subdivision of Moldavian Tableland, drained by Barlad river are strongly affected by erosion processes that have a great impact under the quantitative and qualitative surface water from this area.

Specifically of Barlad watershed natural conditions reflected in general management system review it was manifested by the help of tow major elements:

The positioning in a temperate continental climate's: the torrential rain frequency is more than 20% and the aggressiveness rain factor is K_a= 0.13, characteristics from rivers are the great difference between minimum flow (these could be zero) and maximum flow who are growing

(these could be from one hundred time great then medium value). Rivers from Central Moldavia Tableland are described through: a great volume of spring flowing (41.3% from annual value); in 90% from events the high flood where caused by rains; the period of great level of water is between February and March when there are stabile conditions of winter temperature, when the condition of winter temperature are instable (40% of events) through successive snow melting the level of water are more attenuated, the winter flow instable who forward 13.0% to 20.0% from annual volume. Rivers from Tutova Hills are described through: improving the instability of winter events and an attenuate the great water level from spring (40.0% from events); value of winter flow is like summer flow (16% to 22% from annual flow), the autumn flow is only 15% from annual flow and the maximum annual flow appear only in 50% in summer.

We can say that the supply of hydrographic network of this area are prevalent made from rain, with capriciously events, but in general with same variation between the year. Flow under annual average (30% to 35% from annual average) from august to february and from march to june flow is from 1.5 to 2.0 bigger then annual average flows with a maximum in june.

The control factors regime of sediment production: the flowing coefficients are very high $C_s = 0.39\text{-}0.42$ (slope of 16-38%); the prevalent silting facieses are favour a high density of gully erosion forms (0.8-1.0 kilometres/square kilometre and depth more then 15-20 metres) and area soils moulded in common on feeble bed rooks (gray; brown podsol and podsols; leached chernozems), have an very high erodability factor $S = 0.8\text{-}0.9$;

The management of surface water from Barlad watershed are assured by Vaslui Water Management System, like a subdivision of Water Direction Prut from Romanian Environment Minister, who manage all water from Vaslui county and a part from Iassy Neamt, Bacau and Vrancea county in Prut and Barlad watersheds on an 5606 square kilometres area (1520 square kilometres in Prut watershed and 4086 square kilometres in Barlad watershed).

The length of classified hydrographic network is 2329 kilometres (806 kilometres in Prut watershed and 1523 kilometres in Barlad watershed). The most important classified river are: Prut 174 kilometres, Barlad 149 kilometres, Tutova 86 kilometres, Vaslui 81 kilometres, Elan 73 kilometres, Crasna kilometres, Racova 49 kilometres, Simila 44 kilometres.

Vaslui Water Management System managed the following reclamation works: dykes 482.786 kilometres, stream bed regulation 331.119 kilometres, bank protection 12.965 kilometres, five diversions (Prut-Bârlad, Rediu-Puscaşi, Simila-Râpa Albastră, Rediu-ST Delea and Bârlad-SP Rediu), tow water intakes (Rediu and Simila), five pumping stations (Rediu 1, Rediu 2, Simila, Prodana and rainfall evacuation) and 33 exploitation buildings.

The informational network is assured by one central hydrological station, 56 hydrometric gauging points, 62 rains points, tow vapour-transpiration points, 29 points for ground water studies and 67 hydrogeological drills.

Vaslui Water Management System accounts a number of 664 users (131 consumption users, 533 non consumption users).

In the drainage area of Bârlad river where realised and exploited, since 1960, 47 reservoirs (about 4.2 % from Romanian hill lakes) from earth dam with 2 to 18 meters height and 100 to 1,000 meters longer at the crowing. These reservoirs, at the beginning, totals at NLR (normal level retention): 2,425 hectares water surface; 244.3 billions cube meters (about 7% from maximum utilisable volume created from Romanian hill lakes water volume) for different utilisations like: water supply–52.8 billions cube meters; irrigation's–9.57 billions cube meters; fish breeding–18.73 billions cube meters; pleasure–140 billions cube meters and other utilisation's–3.23 billions cube meters. Bârlad watershed's reservoir also totals 70.98 billions cube meters for high flood attenuated and 88.83 billions cube meters for flood forestalls.

The retention of water in these reservoirs is assured by 43 earth gravity dams and 3 retention dykes.

These 47 reservoirs from Barlad watershed have more using but we can appreciate that 5 of them are main used for water supply, 8 for irrigation, 39 for fish breeding, 16 for pleasure and others, 29 for high flood attenuated and 18 for flood forestalls (figure number 3)

The highest volume distribution of this reservoir is:
- 11% with water volume less then 50,000 cube metres;
- 25% with water volume from 50,000 to 200,000 cube metres;
- 15% with water volume from 200,000 to 500,000 cube metres;
- 8% with water volume from 500,000 to 1,000,000 cube metres;
- 9% with water volume from 1,000,000 to 10,000,000 cube metres;
- 13% with water volume more then 10,000,000 cube metres;

The reservoirs are from following tips:
- 41 permanent reservoirs with supply from own watershed;
- 3 permanent reservoirs with supply from derivation;
- 41 permanent reservoirs with supply from pumping;
- 2 non permanent reservoirs;

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Research location

Researches are made in the drainage area of Bârlad river. Concerning sedimentation process it was made systematically determinations on six of 47 reservoirs: Puşcaşi – Racova watershed; Cuibul Vulturilor – Tutova watershed; Râpa Albastră - Simila watershed; Fichiteşti - Pereschiv watershed; Antoheşti - Berheci watershed and Găiceana - Ghilăveşti watershed (figure 4). The determinations and the examinations are start since 1992 and there are continue at present.

Regarding water quality degradation it was made systematically determinations only of Cuibul Vulturilor reservoir.

Figure 4 Reservoir studded from Barlad river watershed
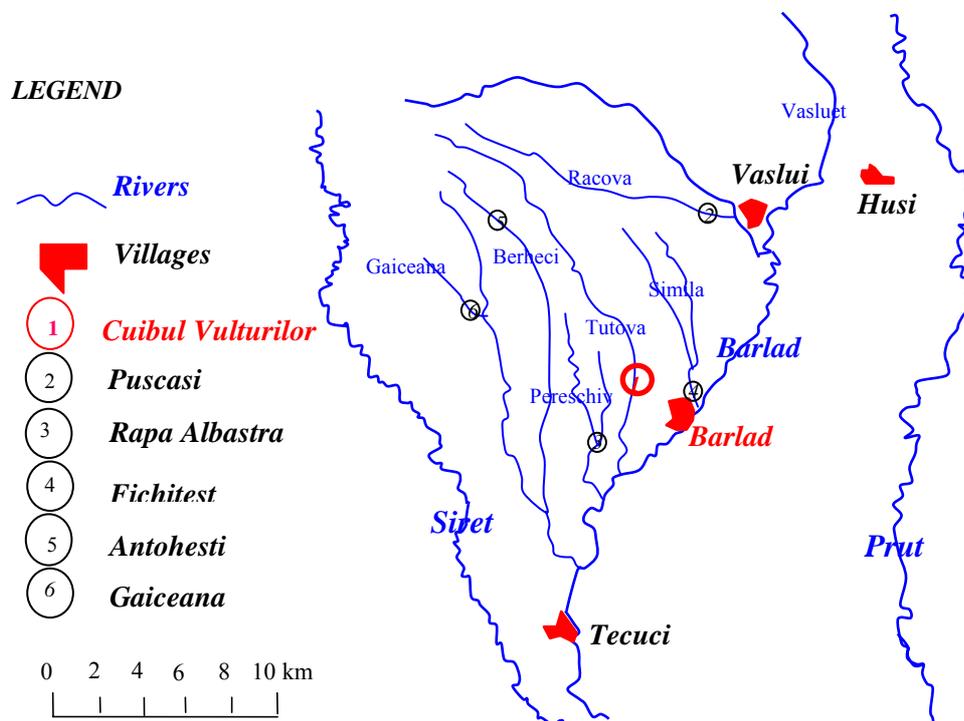
Research method

It was catalogued the natural conditions and prevalence dominates erosion's form from watersheds and the effect of these erosion forms, equipped and unequipped, through determinations and examinations on the sedimentation reservoir. At the same time it was establish sedimentation rank and it was also estimate average year ratio of sedimentation. Thus it was praised the different

contribution from proceeding area and generating process to reservoir's sedimentation, the different give than the erosion forms and from the way of erosion equipment or the absence of these. All this to establish a specifically draft frames to decrease more possible the sedimentation process.

Following the behaviors of land reclamation works from the excessive influence area

These were made using the estimated and measurement erosion date as well as using the topography measurement made in the mentioned area. Concerning surface erosion it was follow tow area types: land without reclamation works and wrong cultivate concerning erosion and land with reclamation works and adequate cultivate concerning erosion. Concerning gully erosion (from slope or valley) it was follow three types: natural fixed form; active form without erosion control works and active form with erosion control works.

The alluvial effluence from excessive influence area

These measurements were effectuated at different events (brusque snow thawing, rain events with height quantity or a long standing) that produced runoff and erosion. The measurements were consisting in: following and registration of variable level in reservoir and the registration of water volumes that enter in this, at different events; drawing and analysing water probes entering in reservoir direct from excessive influence area, at different events and rebuild the flood discharge and speedy measurements concerning surface erosion through streaming and gutters.

The rate and modes sedimentation of studied reservoir determination

The sedimentation of these reservoir, at NLR (normal level retention-semi permanent average exploitation level), was set by bathymetric and topographic measurements on a different number of transverse profiles. These profiles were remade first after 4 then after another 3 years (only some of the profiles, seen as typical for the description of the sedimentation process). In order to achieve these measurements and to re-make them at various intervals (3 or 4 years) transverse profiles were materialised, which cover the whole water table of the reservoir, spaced off 100 to 500m. Along the length of these profiles bathymetric measurements were made every 30m (by means of a cable with fixed spaced floats) on a floating platform mechanically powered. These were followed by topographic measurements on both banks, in order to provide a reliability of 1.0 $^0/_{00}$.

Degradation (pollution) of the water quality under the influence of the loss of nutrients

The degree of degradation (pollution) of the water quality under the influence of the loss of nutrients due to the erosion process, was established by monitoring the concentration of these elements at the intake points of the Cuibul Vulturilor reservoir (rivers: Tutova, Iaura, Roşcani and Cârjăoani – the last three with non-permanent regime) and at the water intake points. Between 1996 and 1999 a number of 204 samplings were taken from the frontal intake point (Tutova river), 306 samplings from the lateral intake points (rivers Iaura, Roşcani and Cârjăoani) and 102 samplings from the main intake area. Water samples were taken manually or with an ISCO (Automatic Water Sampler), during normal discharge flow and during or after hydrologic events, from February to October. The gathering, preparation and conservation of samples for were made according to the current Romanian standards.

In this case the principal elements studied were: nitrogen, under the form of nitrates colorimetric determined with acid phenol 2÷4 disulfonic; ammonium nitrogen - colorimetric determined with reactive Nessler; phosphorus – like blue molybdenum colorimetric dosing, and potassium - in flame photometry dosing.

Results obtained

Specifically area's natural conditions reflected in general sedimentation system review it was manifested by the help of tow major elements:

The positioning in a temperate continental climate's: the torrential rain frequency is more than 20% and the aggressiveness rain factor is K_a= 0.13. The Bârlad watershed rivers are operating through: an unstable winter regime and the attenuation of big spring water (about 40% from cases); the winter leakage volume are like in summer (represent 16-22% and respectively 21-22% from yearly leakage volume; the autumn leakage is only 15% from yearly leakage volume; the most yearly discharge flow is produced in only 50% from case in summer.

The control factors regime of sediment production: the leaking coefficients are very high C_s = 0.39-0.42 (slope of 16-38%); the prevalent silting facieses are favour a high density of gully erosion forms (0.8-1.0 kilometres/square kilometre and depth more then 15-20 metres) and area soils moulded in common on feeble bed rooks (gray; brown podsol and podsols; leached chernozems), have an very high erodabillity factor S = 0.8-0.9;

Erosion from excessive influence area regarding sediments transport

In the area regarding sediments transport of reservoir, there are all erosion forms less then landslides. On the agricultural land with same slope sheet erosion was between 10 to 12 to/hectares on equipped lands and was between 30 to 35 to/hectares on unequipped lands. Sheet erosion on the unequipped area is about three times large then sheet erosion of equipped area.

During the fast snowmelt from february-march 1996 (in the same area) it was making on the left bank upstream of dam, a slope gully (about 235–250 meters length, 4-10 meters depth). From this slope gully, in reservoir, it was enter 5,400 m^3 sediments (estimated).

Concerning the gully erosion in the third lower part of equipped slope gully every year it appear under washing processes materialised through 3–4 rapids from 0.5–1.5 meters. As result of these rapids where eroded about 80–120 m^3/rapid of material who are going to the reservoir like sediments. On the valley gully, equipped with crossing sedimentation control works, the alluvial deposits usually are at the level of the weir but scouring phenomenon is appearing on the intervals of sedimentation control works. These scouring phenomenon produce about 2,400-m^3/km length that is going to the reservoir like sediments.

The alluvial effluence from excessive influence area

The sediment effluence, from excessive influence area concerning sediments transport into the reservoir (determinate at the same events) (table 1).

Table 1

The sediment effluence and the sediment volume coming into the Cuibul Vulturilor reservoir, from the excessive influence area, annual mean of the events from 1996 – 2000

Location /micro watersheds	Area (ha)	Effluence sediments (to/ha)		Sediment's input into the reservoir (m^3)	
		Event		Event	
		Snowmelt	Long term rains	Snowmelt	Long term rains
Left hill side	372	8,89	9,87	4.639	5.158
Roşcani watershed	742	25,36	30,52	26.432	31.797
Pogana village area	146	1,22	1,44	249	293
Iaura-Tomeşti watershed	2242	1,80	2,18	8.833	6.847
Cârjãoani watershed	1872	8,35	10,74	21.972	28.646
Right hill side	353	7,93	9,00	3.931	4.463
Means/total volume	event	5,03	6,18	66.056	77.204
	events				143.260

From the date presented (table 1) it coming out that the bigger sediment effluence provide from the micro watersheds who are directly coming into the reservoir (7.93–9.87 to/hectares from the direct slopes and 1.8–30.5 to/ha from these kind of micro watersheds.

After mean annual rata in this reservoir coming in about 221,430-m3 sediment, but only to the remarkable events from excessive influence area it coming into the reservoir about 143,260-m3 sediment, that means about 65.0% from the total sediment coming into the reservoir. From these sediment volume, coming into the reservoir, 13.1% provide from the directly slope area and the difference provide from micro watersheds who are coming directly into the reservoir. These data point out the contribution of singular remarkable events to the sedimentation of the reservoirs through the great sediment effluence in comparative with mean annual sediment effluence currently used in the plan to establishing the sediment volume of the reservoirs.

The rate and modes sedimentation of studied reservoir

Results obtained, for hill lake from Bârlad watershed (table 2) making the evident distinguish value of the annual rate and rhythm of sedimentation (reported at the initial water volume at NLR) varying with watershed and their emplacement into these:

Table 2

Initial and present characteristics of few reservoirs from Barlad watershed

Specifications	M. U.	Reservoirs name					
		Puşcaşi	Cuibul Vulturilor	Râpa Albastră	Fichiteşti	Antoheşti	Găiceana
Initials characteristics							
Year of exploitations coming		1973	1978	1979	1977	1984	1984
Watershed		Racova	Tutova	Simila	Perschiv	Berheci	Berheci
River		Racova	Tutova	Simila	Perschiv	Berheci	Ghilăveşti
Dam's type		Earth's dam					
Dam's height*	m	17	17	18	14	6	7
Crossing's longer*	m	890	843	810	700	350	320
Watershed area	ha	29600	54200	25300	16300	3963	4665
Water surface	ha	224	345	230	180	25	28
Water volume at NLR	m^3	17000000	9500000	10600000	5500000	220000	410000
Anticipation sediment volume	m^3	600000	300000	200000	200000	40000	40000
Sedimentation's average year ratio	m^3	15000	6000	4000	4000	4000	4000
Present characteristics							
Determination year		1998	1992	1993	1993	1995	1995
Exploitation years		26	14	14	16	10	10
Initial water volume at NLR (V_i)	m^3	17200000	9500000	10600000	5500000	220000	410000
Waters volume at determination time	m^3	6300000	6400000	8360000	2610000	130000	240000
Sediments volume at time	m^3	10900000	3100000	2240000	2890000	90000	170000
Sedimentation rate	% of Vi	63.37	32.63	21.13	52.54	40.91	41.46
Sedimentation average annual rata	m^3/an	419231	221430	160000	180625	9000	17000
Sediment effluence	m^3/ha	14.16	4.08	6.32	11.08	2.27	3.64
Sedimentation average annual rhythm	% of Vi	2.44	2.33	1.51	3.28	4.09	4.15

* At dam's crest

• The reservoirs Antoheşti and Găiceana, who was placed in superior and middle part of Berheci watershed have an sedimentation rate of 40.91 % and 41.46%, with an sedimentation average annual rhythm of 4.09 % and 4.15 %;

• Cuibul Vulturilor reservoir placed in lower Tutova watershed is deposited in 32.63% and she realise an sedimentation average annual rhythm of 2.33%;

• Râpa Albastră reservoir from lower Simila watershed have an sedimentation rate of 21.13% with an sedimentation average annual rhythm of 2.33%;

• Fichiteşti reservoirs from lower Perschiv watershed are the most affected by sedimentation, her sedimentation rate are 52.6% with a sedimentation average annual rhythm of 3.3%.

The analyse of sedimentation trend, best describe from polynomial relation of degree tow, from Tutova Hills reservoir considering some proper morphologic parameters permit few assessments concerning the conditions from placing and realising of new reservoir on area.

Sedimentation annual mean rata is decreasing through reducing of the watershed area until one limit then this limit is growing again. The same trend are relying on the initial area of water at NLR, these are explained by fact that the small watershed are the same with excessive influence area. Relying on excessive influence area regarding sediments transport and the initial water volume the trend is decreasing at the same time with these tow parameters. The lower value of sedimentation annual mean rata are realise when: the watershed area is between 30,000 and 40,000 hectares; the surface of excessive influence area regarding sediments transport is < 4,000 hectares; the initial water volume at NLR is > 6,000,000 m^3 and the surface of water at NLR is between 200 and 260 hectares.

Concerning the distribution of sediments it were analysed comparatively the longitudinal profile (Figure 2) and two cross profiles (Figure 3 and 4), which were considered typical for the description of the sedimentation process. This analysis outlines the thickness and the distribution of sediments.

The thickness of the deposited sediment throughout the length of reservoir has maximal values close to dam, thinning out to the end of the reservoir.

On the small reservoir (depth of water between 2 to 4 meters) with the watershed identifying with excessive influence area regarding sediments transports the results remark a relative uniform distribution of sediment deposits on longitudinal and cross profiles. On bigger reservoir, where the excessive influence area regarding sediments transport is between 2 and 10 % from watershed area, but these are order of same thousand hectares (comparatively with all watershed of the small reservoir) situation are different. The restoration of bathymetric and topographic profiles from 1992, on the same alignments, in 1996 and 1999, permitted, by comparing them, to differentiate the thickness of deposited sediment at different areas of the reservoir. The initial profile from 1978 was realised with the help of topographical plans (scale 1/5,000).

Figure number 2

Longitudinal profile Cuibul Vulturilor reservoir
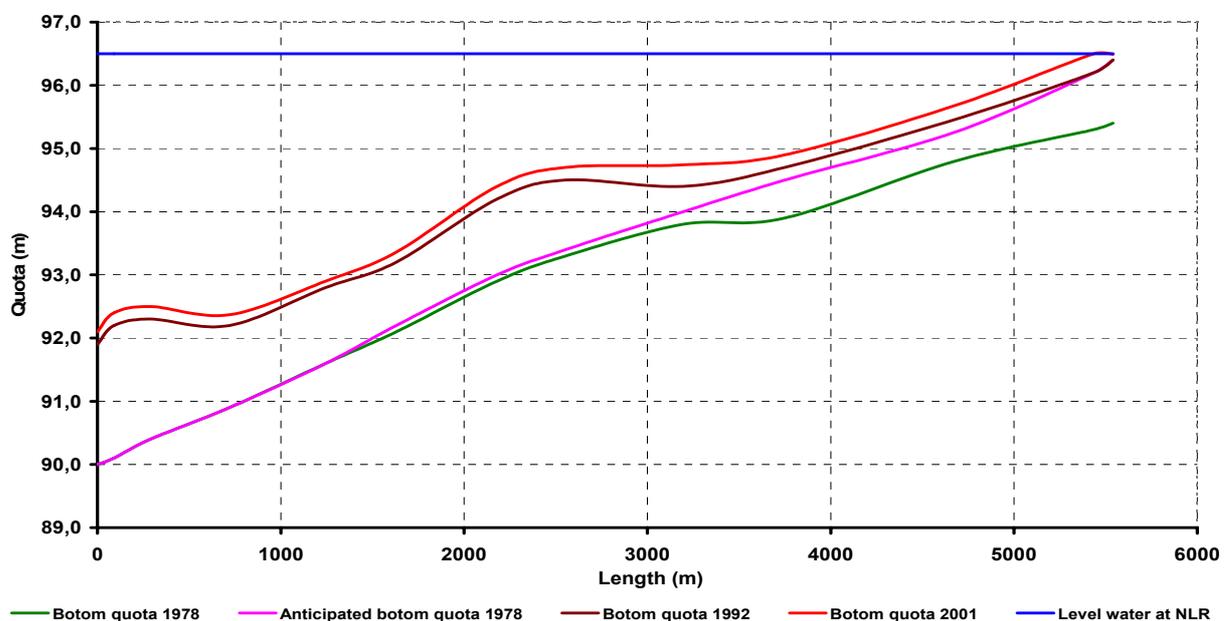
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The profile P1, situated in the area of direct influence of watershed Cârjăoani (with a valley gully as the predominant form of erosion):

- After fourteen years of exploitation, the deposits are unevenly with a thickness of 2.5 m on the left bank, 1.8 m in the central area and 3.5 m on the right bank. In this case the average annual ratio of sedimentation was 0.16 – 0.13 – 0.25 m. throughout the length of the profile.

- In four years the deposits were relatively evenly distributed 0.4-m on the left bank, 0.3-m in the central area and 0.6-m on the right bank. The average annual ratio of sedimentation was 0.10 – 0.08 - 0.15 m throughout the length of profile;

- In three years the deposits were clearly unevenly distributed 0.1-m on the left bank, 0.2 m in the central area and 0.7 m on the right bank. The average annual ratio of sedimentation was 0.03 – 0.06 - 0.23 m's throughout the length of the profile.

The profile P4, situated in an area without the direct influence of a watershed area, only with the influence of a nearby hill:

- After fourteen years of exploitation the deposits were evenly distributed with a thickness of 1.2 m on the left bank, 1.4 m in the central area and 1.5 m on the right bank. The average annual ratio of sedimentation was 0.09 – 0.10 – 0.11 m. throughout the length of the profile;

- In four years the deposits were fairly evenly distributed 0.13-m on the left bank, 0.16 m in the central area and 0.12 m on the right bank. The thickness of the sediment grows to the centre of the profile and fingers out to both banks, as the result of the lower charges of hill stream flows. The average annual ratio of sedimentation was 0.03 – 0.04 – 0.03 m throughout the length of profile;

- In three years the deposits were thicker to the centre of the profile and to both banks, as a result of the lower charges of hill stream flows. The thickness of the sediment was 0.10 m on the left bank, 0.20 m in the central area and 0.10 m on the right bank. The average annual ratio of sedimentation was 0.03 – 0.06 – 0.03 m throughout the length of the profile.

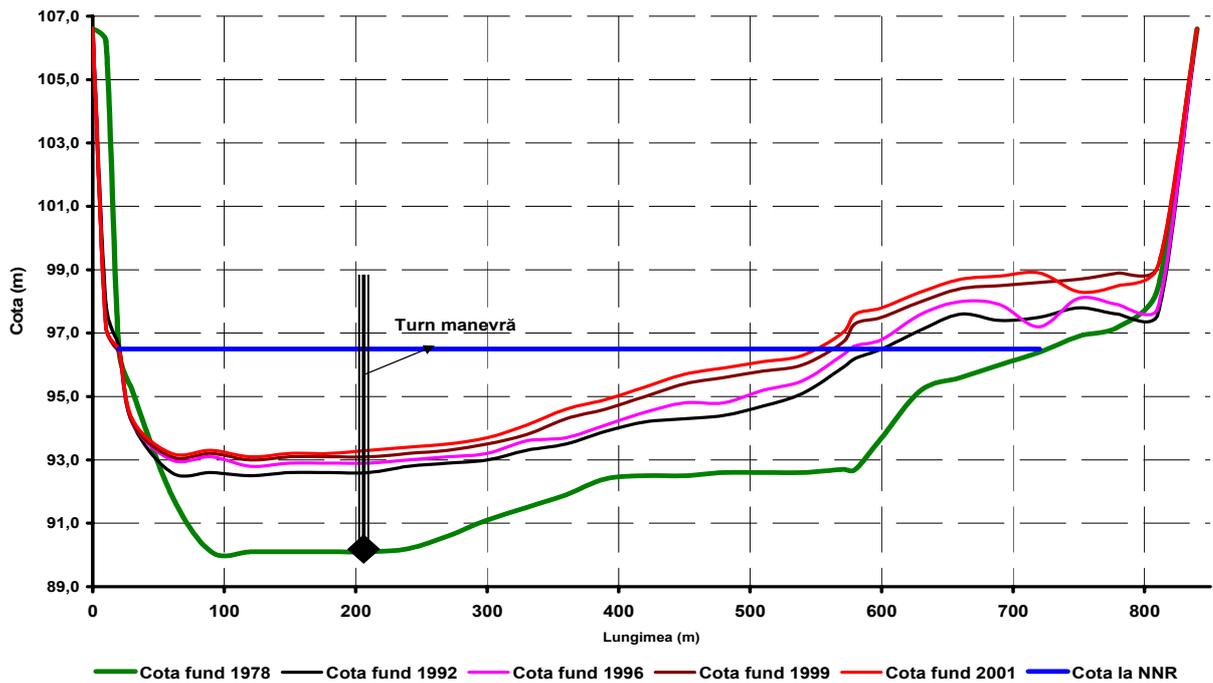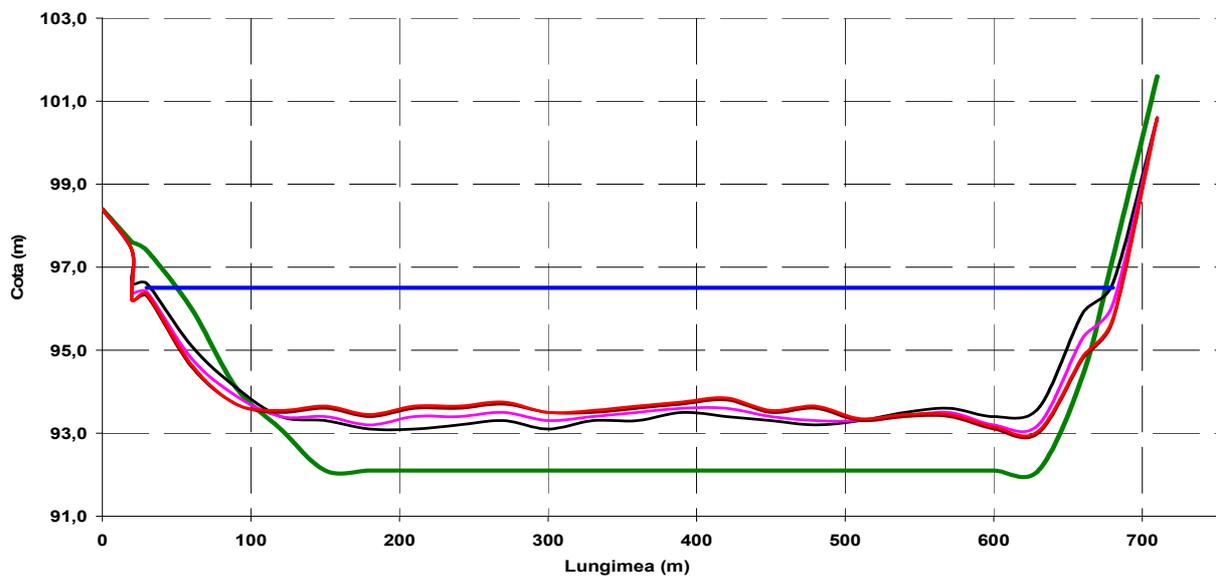Figure number 3

Cross profile 1 Cuibul Vulturilor reservoir

Figure number 4

Longitudinal profile 4 Cuibul Vulturilor reservoir

Degradation (pollution) of the water quality under the influence of the loss of nutrients

As regards the dynamic nitrogen, under the form of ammonium nitrogen (Figure number 5) we noticed an increase in the average monthly values in April and October; a process accountable by the fact that in this period the vegetation is less developed, therefore the soil is less protected from erosion. The increase in concentration of June is due to the fact that rainfalls are at their highest and wash away nitric nitrogen. Maximal values of 37.2 PPM (Table 1) do not exceed the limit of 45 PPM permitted by STAS for this category, while the minimum values are characteristic for a normal discharge flow.

Figure number 5

Nitrogen, under ammonium nitrogen form, on frontal and laterally entrance and form plug area during 1996 - 2001
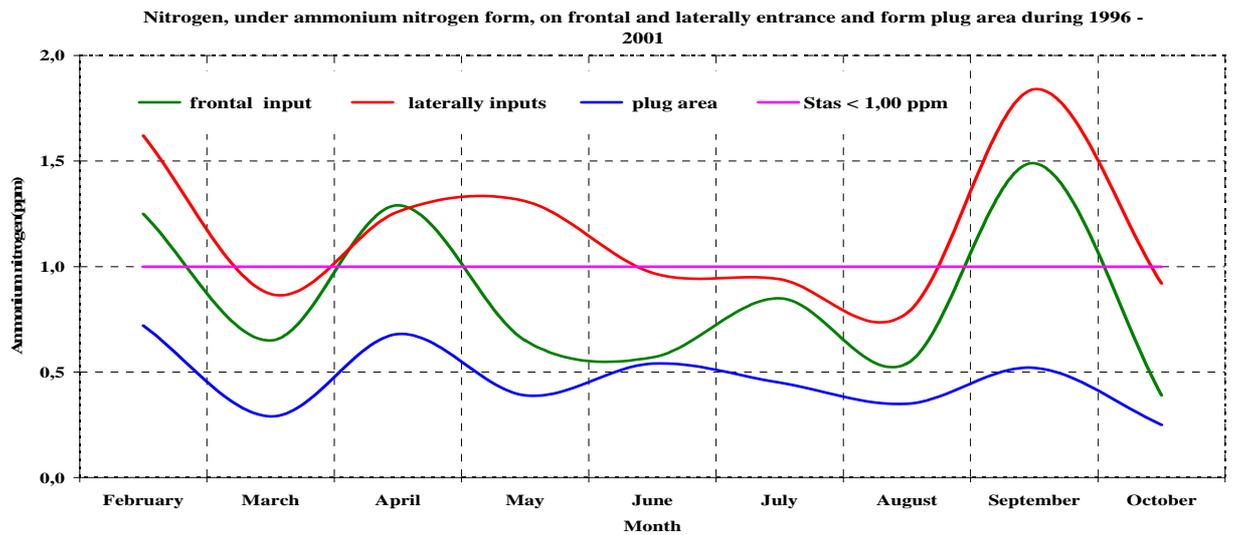
Nitrogen, under the form of ammonium nitrogen, being trapped in the adsorbent soil complex, is hard to wash, compared to nitric ion nitrogen. The increase recorded during the spring season and in September (Figure number 6) is due more to ammonium nitrogen, which comes from manure washing, containing 0.32 – 5.82 % nitrogen - 1/3 under ammonium form (Davidescu D. and V., 1978). The data in Table 2 show that although the maximal monthly value at intakes exceeds the value permitted by Romanian standards – 1 PPM for first use category in plug area with an annual average value of 0.47 PPM, allow us to set the reservoir in this category.

Figure number 6

Dynamic nitrogen, under nitric nitrogen form on frontal and laterally input and form plug area during 1996 - 2001
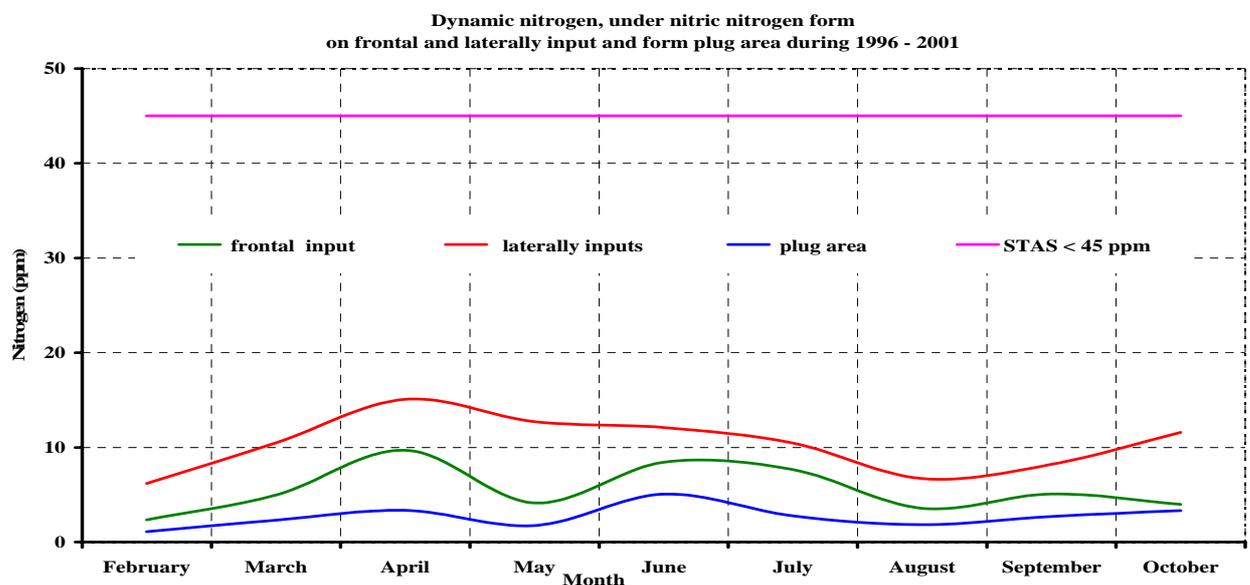
Table 1 shows the average annual value of nitrogen as an element under nitric and ammonium nitrogen form – the sum of which is considered to form the mineral nitrogen. In fact the nitrogen lost from agricultural lands, by water leaks, amounts to 5 – 20 % and that lost due to soil erosion amounts to 80 – 95 % of the total loss of nitrogen. Part of the soil eroded (with organic nitrogen) is found in the reservoir. In conclusion we can tell that the washed out nitrogen greatly contributes to the acceleration of the eutrophyc process of the reservoir, a process characteristic reservoirs with total nitrogen content larger than 1.5 PPM (Cojocaru I., 1995).

Table number 1

Average year value of studied elements, on frontal and laterally inputs and form plug area
of Cuibul Vulturilor reservoir, during 1996 – 2001

Value	Laterally input	Frontal input	Plug area
Ammonium nitrate			
Minim	3,76	2,13	1,10
Maxim	37,2	20,37	5,07
Year average	10,39	5,54	2,69
Ammonium cation			
Minim	0,30	0,23	0,18
Maxim	5,10	3,60	1,18
Year average	1,00	0,85	0,47
Ammonium mineral			
Nitric ammonium	10,39	5,54	2,69
Ammonium nitrogen	1,00	0,85	0,47
Ammonium mineral	11,39	6,39	3,16
Fosfat anion			
Minim	0,24	0,20	0,20
Maxim	2,02	0,86	0,31
Year average	0,55	0,38	0,24
Potasium cation			
Minim	5,2	4,0	4,7
Maxim	56,6	23,6	12,0
Year average	11,7	10,7	8,3

From the dynamics of phosphorus anion (Figure number 7), we find that the evolution of this anion is similar to that of the nitrogenous anion, with concentrations increasing in the spring season, when the soil is less protected from erosion, and in June, a month with a high level of rainfall. The loss of phosphorus is lower than that of nitrogen because it is fixed in the soil and it is less likely to migrate (Buckman and Brady, 1961). Although at the reservoir intake points the value is higher than 0.5 PPM – the value allowed by Romanian standards for first use category (Table 1), in the plug area the quality of the water is not affected. The contribution of mobile phosphorus (under the form of phosphorus anion in water) to the total phosphorus share in reservoir is from 0.08 to 0.18 PPM in the eutrophization process (total phosphorus higher than 0.15 PPM).

The greatest loss of potassium (Figure number 8) is in June, with two smaller intensity peaks in April and September. The category of the reservoir is not affected by the loss of potassium (K^+).

Phodphorous dynamic's, under phosphorus anion form, on frontal and laterally entrance and form plug area during 1996 - 2001

Potasium dynamics, on frontal and laterally and form plug area during 1996 - 2001
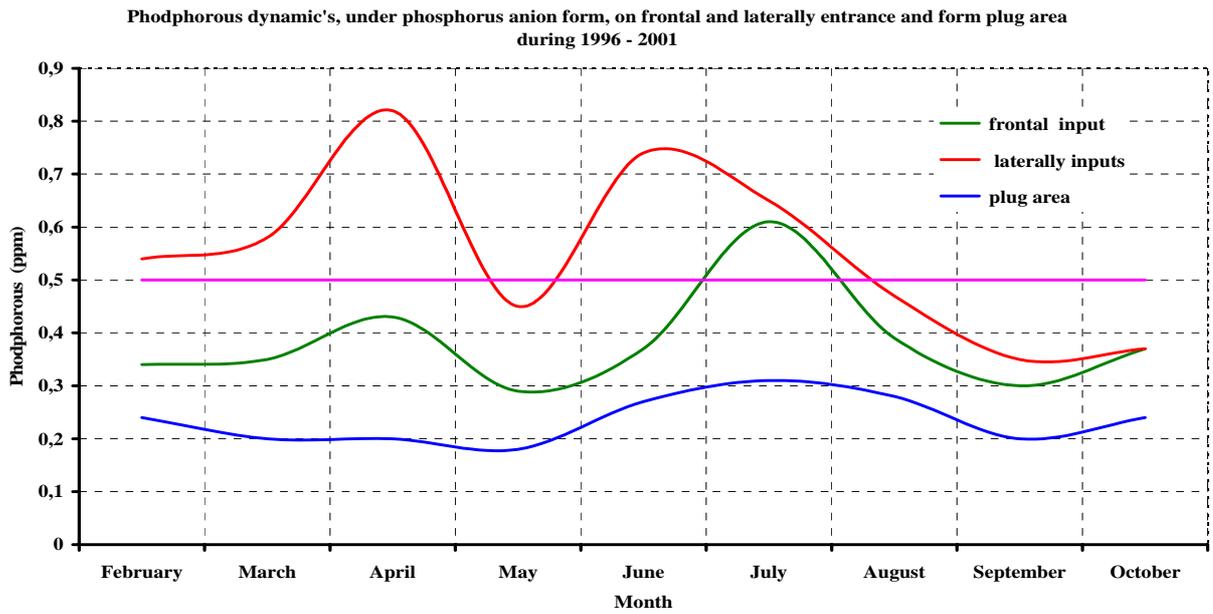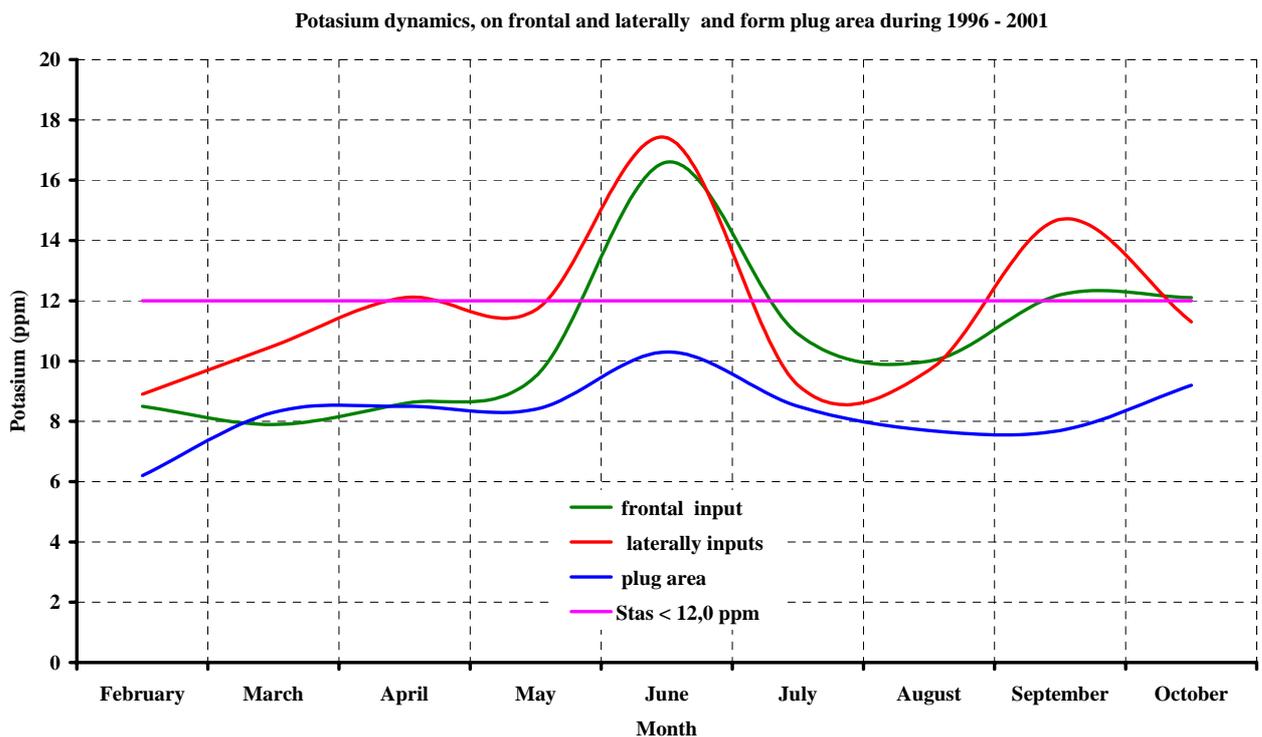

Conclusions
As concerns the sedimentation process

Rank and mean annual rhythm of sedimentation, for the reservoirs from Bârlad draining area, are differentiate in accordance with the watersheds and their placement into among the watersheds.

Sedimentation rank: > 41 % from initial volume for these from Pereschiv watershed; < 33 % from initial volume for these from Tutova and Simila watersheds; > 63 % from initial volume for these from Racova watershed;

Mean annual rhythm of sedimentation: > 4.1% of initial volume for these from middle and upper part of watersheds; < 3.3% from initial volume for these from lower part of watersheds;

The small mean annual rhythm of sedimentation from the reservoirs placed in drainage area of Bârlad river are realised when: - watershed area is between 30,000 and 40,000 ha; the area of the excessive influence area regarding sediment transport is less then 4,000 ha; initial water volume at NLR is bigger then 6,000,000-m3; the water surface at NLR is between 200 and 260 ha.

Every year the water surface at NLR is reducing mean on a $0.74 - 1.00$ %.

Along cross profile there are a different mean annual sedimentation rata: uniform ($0.09 - 0.11$ m) where isn't influence from lateral inputs and uninformed in area with directly influence of input from micro watersheds (0.53 m in the nearby of the input, 0.18 m in the middle area and 0.09 on the opus bank).

The sedimentation rhythm and the thickness of sediments in area of directly inputs of the micro watersheds are from $4 - 5$ times bigger then the area influenced only from the nearby slope of water area.

The mean annual rata are in general from 20 times bigger than prognosis (221,430-mc comparative with 10,000-mc for Cuibul Vulturilor reservoir.

The thickness of the deposited sediment throughout the length of reservoir has maximal values close to dam, thinning out to the end of the reservoir. The same was noticed about the granulometry of the sediment: it is finer at the far end of the reservoir and rougher close to the dam.

The restoration of bathymetric measurements make render evident the thickness of sediment about 0.15 to 0.75 m (sediment stored in three years) with a means annual rata of sedimentation, in these period, from 0.05 to 0.25 m /year.

65 % from sedimentation mean annual rata provide from the excessive influence area (area placed nearby the surface of water.

From the total volume of sediments, carry on into the reservoir from excessive influence area, 13.1 % provide from the slope (sheet erosion and slope gully) and 86.9 % provide from the micro watersheds with directly input into the reservoir (gully erosion and transport of sheet erosion from the watershed).

As concerns the degradation of the water quality degradation of Cuibul Vulturilor reservoir, we can conclude:

The main fertiliser elements used in this area are: nitrogen, phosphorus and potassium;

As a result of the dilution process, in the direct intake area the water quality is not affected;

In June, when the level of precipitation is highest, the concentration of the studied elements is also at its highest;

The highest concentration of the studied elements is recorded at the lateral intakes;

In sprig and the beginning of autumn, when the soil is insufficiently protected against erosion, the contents in fertiliser elements increase in the supply sources of the reservoir;

The highest concentrations are recorded in the nitrogen and potassium because these are not strongly retained by the adsorbent complex of the soil.

Fertilisers used on agricultural land are not a source of degradation of the quality of surface water.

From a chemical viewpoint, the reservoir sediment is slightly alkaline (7.1-8.4), the content of humus is very small to small ($0.3 - 1.9$ %) and poor in total nitrogen ($0.02 - 0.10$ %), which leads to insignificant influence in the degradation process of the reservoir water.

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