MINIMUM DISCHARGE IN BAHLUI BASIN AND ASSOCIATED HYDROLOGIC RISKS

I. MINEA[1]

ABSTRACT. – Minimum discharge in bahlui basin and associated hydrologic risks. The inventory and determination of the periods with reduced discharge was conducted based on the data from the main hydrometric stations in the basin, through the analysis of the mean daily discharge data from the 1950-2005 period. In relation with the climatic and hydrogeologic conditions, at the level of this hydrographic basin may be distinguished two large periods of reduced discharge. One is characteristic to the winter period, when water coming from rainfall is stored as snow and ice. The second occurs at the end of summer and the beginning of autumn, when the frequency of dry or drought periods is high, the values of evapotranspiration being very high, and the degree of water use for practical uses (irrigations) is quite increased. The analysis was made to show the importance of some statistical parameters (like minimum discharge, variation coefficient, square mean error etc) who hept us to determinate the frecquency of the depletion phenomena in this drainage basin.

Keywords: Bahlui drainage basin, minimum discharge, associated hydrological risks

1. INTRODUCTION

The factors that control the occurrence of minimum discharge rates are represented by the climatic and hydrogeologic conditions from different periods of the year (*Gottschalk* et. al., 1999). Along these, anthropic activity, through water extractions for different purposes or water inputs from some socio-economical activities, may have a categorical influence on the characteristics of minimum discharge.

The irregular variation in time and space of atmospheric rainfall, the extreme values of air temperature and the intensification of evapotranspiration at the soil level, in the conditions of a specific dynamic of air masses, are the main climatic factors that contribute to the occurrence of a reduced discharge in this basin (Pantazică Maria, 1971).

To these are added and the subterranean water reserves and the reduced restitution capacity of the substratum in some parts of the basin. The high areas that surround the basin in the southern and western part behave as rich reservoirs of aquifers of high depths, with a permanent restitution capacity (with the exception of the southern part of the basin, in Iasi's Cuesta, where the drainage, due to the

[1] „Al.I.Cuza" University, Faculty of Geography and Geology, 700505 Iasi, Romania, e-mail: ionutminea1979@yahoo.com

orientation of the geologic strata, is made dominantly towards south to the basin of Barlad River). In comparison, the lower area from the central and northern parts of the basin, in the conditions of a more clayey facies, allowed the development of aquifer strata at small depths, of a smaller restitution power. Here, at the formation of surface runoff a consistent input is brought by the underground waters from the terrace and alluvial floodplains deposits.

A special situation is represented by the contact area between the high hilly frame and the lower plain part, where rivers that come from the plateau region lose a large part of their discharge through infiltrations in the permeable deposits (sands mainly), sometimes up to total exhaustion.

2. EVALUATION OF MINIMUM DISCHARGE IN BAHLUI BASIN

The inventory and determination of the periods with reduced discharge was conducted based on the data from the main hydrometric stations in the basin, through the analysis of the mean daily discharge data from the 1950-2005 period. During this time interval, reduced discharges (when the value of the monthly module coefficient has been lower than 0.25 l/s/km^2) were registered in the winters of 1953-1954, 1962-1963, 1963-1964 and the summers of 1954, 1958, 1959, 1962, 1992 and 2000.

In relation with the climatic and hydrogeologic conditions, at the level of this hydrographic basin may be distinguished two large periods of reduced discharge. One is characteristic to the winter period, when water coming from rainfall is stored as snow and ice. The second occurs at the end of summer and the beginning of autumn, when the frequency of dry or drought periods is high, the values of evapotranspiration being very high, and the degree of water use for practical uses (irrigations) is quite increased.

In the conditions of this basin have been frequently registered instantaneous minimum discharges lower than 0.001 m^3/s and even the phenomenon of total water depletion, as results from the analysis of the mean daily discharge rates (Table 1).

The number of such situations in relatively small, yet it shows the strong influence of the climatic conditions on river discharge. In the warm season of the year, due to atmospheric rainfall variability, such situations have been registered in 6 cases at Târgu Frumos hydrometric station (4-6.VIII.1954, 16-26.VII.1957, 6-8.VIII. 1957, 16-21.VII.1958, 14-15.VIII.1963, 6-7.IX.1963), in three cases at Podu Iloaiei station on Bahlueț (6.VIII.1954, 24-26.VII.1957, 18-21.VII.1958), two cases at Hârlău station (6.VIII.1954, 6-7.IX.1963) and four cases at Iaşi hydrometric station on Nicolina River (4-6.VIII.1954, 16-26.VII.1957, 6-8.VIII. 1957, 16-21.VII.1958).

In the cold season, the situations of discharge blocking (total freeze), due to the formation of a thick stratum of ice and snow, are much more reduced. They have been registered only during 4-6.I.1957 at Hârlău station, in 5-6.I.1964 at Târgu Frumos and Podu Iloaiei (Bahlueț) stations and in 3-6.I.1964 at Iaşi (Nicolina) hydrometric stations (Table 2).

According to the number of depletion cases registered, we may determine at the level of the entire basin a frequency of this phenomenon, strongly correlated with basin surfaces. This frequency was computed using the following formula:

$$f=(n/N)*100,$$

where: n – number of years with depletion phenomena;
N – number of observation years.

Table 1. ***Instantaneous monthly minimum discharges (m^3/s) in Bahlui basin***

Nr. ctr.	1	2	3	4	5	6
Station	Bahlui	Bahlui	Bahlui	Bahlueț	Bahlueț	Nicolina
River	Hârlău	Podu Iloaiei	Iași	Târgu Frumos	Podu Iloaiei	Iași
I	0.001	0.000	0.053	0.000	0.000	0.000
II	0.004	0.018	0.068	0.002	0.003	0.000
III	0.016	0.017	0.126	0.008	0.036	0.012
IV	0.033	0.032	0.137	0.010	0.017	0.007
V	0.011	0.007	0.098	0.008	0.006	0.005
VI	0.001	0.002	0.040	0.001	0.005	0.001
VII	0.000	0.000	0.070	0.000	0.000	0.000
VIII	0.000	0.002	0.074	0.000	0.000	0.000
IX	0.002	0.002	0.074	0.000	0.001	0.001
X	0.002	0.007	0.080	0.002	0.003	0.001
XI	0.003	0.008	0.118	0.002	0.002	0.001
XII	0.003	0.008	0.035	0.001	0.008	0.001
Qmin.min	0,000 1958, 1960	0,000 1953	0,040 1964	0,000 1952, 1954, 1957, 1960, 1964	0,000 1954, 1957, 1960, 1964	0,000 1951, 1952, 1953, 1960, 1968

Table 2. ***Statistics of monthly minimum discharges in Bahlui hydrographic basin***

Hydrometric station	**Hârlău**	**Podu Iloaiei**	**Iași**	**Târgu Frumos**	**Podu Iloaiei**	**Iași**
River	**Bahlui**	**Bahlui**	**Bahlui**	**Bahlueț**	**Bahlueț**	**Nicolina**
Minimum discarge (maximum value)	0.39	1.16	7.2	0.13	1.24	0.97
Year	1972	1998	1980	1999	1999	1997
Minimum discharge (minimum value)	0.00	0.00	0.04	0.00	0.00	0.00
Year	1958, 1960	1953	1964	1952, 1954, 1957, 1960, 1964	1954, 1957, 1960, 1964	1951, 1952, 1953, 1960, 1968
Minimum discharge (medium value)	0.07	0.24	0.85	0.04	0.18	0.11
Cv*	0.88	0.74	0.72	0.76	0.81	1.00

Hydrometric station	Hârlău	Podu Iloaiei	Iaşi	Târgu Frumos	Podu Iloaiei	Iaşi
River	**Bahlui**	**Bahlui**	**Bahlui**	**Bahlueț**	**Bahlueț**	**Nicolina**
Cs**	1.57	0.83	0.56	0.46	1.08	1.30
Cs/Cv	1.78	1.11	0.77	0.60	1.33	1.29
σ***	0.06	0.18	0.61	0.03	0.15	0.11

Cv – variation coefficient of the data array of annual minimum discharges
Cs – asymmetry coefficient of the data array of annual minimum discharges
σ – square mean error.

In the conditions of Bahlui basin, the frequency of water depletion phenomenon is of 1-3% in the case of basins with surfaces between 300 and 500 km^2, 5-7% for the basins with surfaces between 100 and 300 km^2, 10-15% in the case of basins between 50-100 km^2, 40-50% for those between 15-20 km^2 and over 90% for the basins smaller than 5 km^2 (Fig. 1).

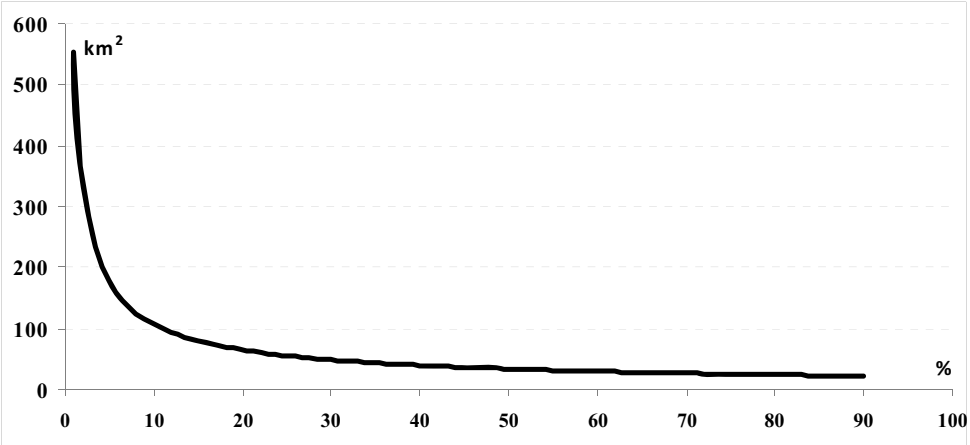

Fig. 1. ***The frequency of depletion phenomena in relation with the basins' surface***

The mean multi-annual duration of the water depletion phenomenon is of one day in the case of the basins having surfaces between 300 and 500 km^2, 3-4 days for the basins of 100 - 300 km^2 and of over 120 days for the basins with surfaces smaller than 4-5 km^2. At a probability of 1% this parameter may exceed 330 days in the case of the basins smaller than 5 km^2 and less than 330 days for the basins having a higher coefficient of forestation.

The general tendency of the registered values of minimum discharges at the level of the entire basin is of increase (the depletion phenomena was registered during 1950-1964), especially due the increase in the degree of hydrotechnical management (*Păduraru Aneta, Popovici,* 1968). This fact may be observed in figure 2, where the values of minimum annual discharge measured at Podu Iloaiei station (on Bahlueț) "have suffered" an important increase after 1968, with the

construction of Podu Iloaiei reservoir, the effect of discharge regularization being more than obvious.

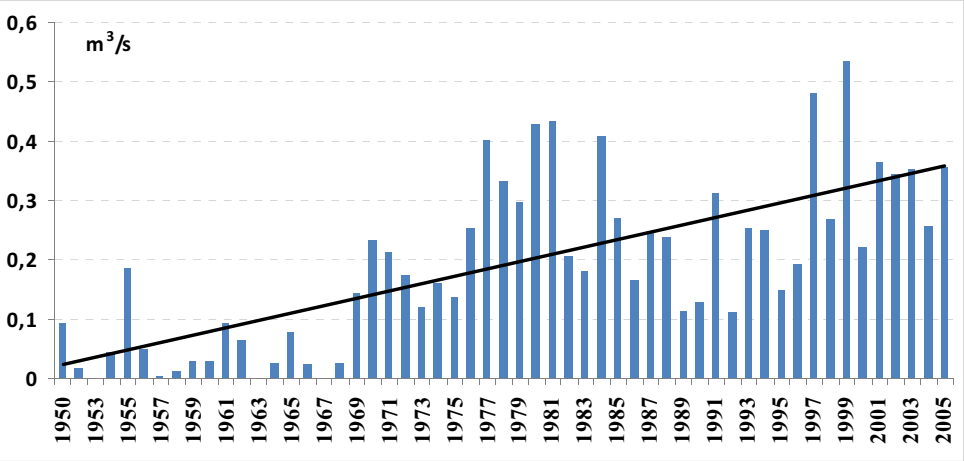

Fig. 2. ***Variation of minimum annual discharge rates at Podu Iloaiei hydrometric station (on Bahluet) during 1950-2005***

For the design and exploitation of water resources, in the hydrologic exercise is needed the familiarity with the insurance degree of the minimum flows for different time periods. In general, for the water alimentation of population and industrial areas are determined the minimum discharges with 95-97% insurances, either for the most soliciting periods (April-September) or for the entire year. In the case of water use in agriculture (irrigations) the calculus insurances for minimum discharges are computed for April-November and are between 75-90%. Another practical aspect of the insurance degree of minimum discharges is connected to the volume of used waters spills into rivers, phenomenon characteristic to human settlements and industrial objectives. *The dilution discharge rate* from which such spills into rivers may be done is the equivalent of the minimum annual discharge with an insurance of 95%.

At the level of the basin have been determined the mean minimum discharge rates with insurances of 80%, 90% and 95% (during 1950–2005) for the main hydrometric stations, having in view the natural flow regime of rivers that is not affected by extractions. The values of minimum discharge rates of different insurances have been determined with *Weibull's formula* (Table 3).

Also, for the determination of mean minimum discharge rates have been computed and a series of normal linear Gauss diagrams with the mean monthly minimum discharges of different insurances, for the hydrometric stations taken into consideration (Fig. 3.).

Table 3. ***Statistics of monthly minimum discharge rates in Bahlui basin***

Nr. ctr.	Hydrometric station	River	Hm (m)	F (km^2)	Q_0 (m^3/s)	Mean minimum discharge rates (m^3/s) with insurances			Qmax/ Qmin
						80%	90%	95%	
1	Bahlui	Hârlău	315	137	0.43	0.020	0.010	0.002	1080
2	Bahlui	Podu Iloaiei	204	588	1.16	0.075	0.050	0.030	1741
3	Bahlui	Iaşi	162	1717	3.40	0.200	0.120	0.080	763
4	Bahlueț	Târgu Frumos	272	71	0.15	0.008	0.002	0.000	2906
5	Bahlueț	Podu Iloaiei	139	500	1.04	0.050	0.020	0.005	1830
6	Nicolina	Iaşi	139	173	0.48	0.010	0.001	0.000	7450

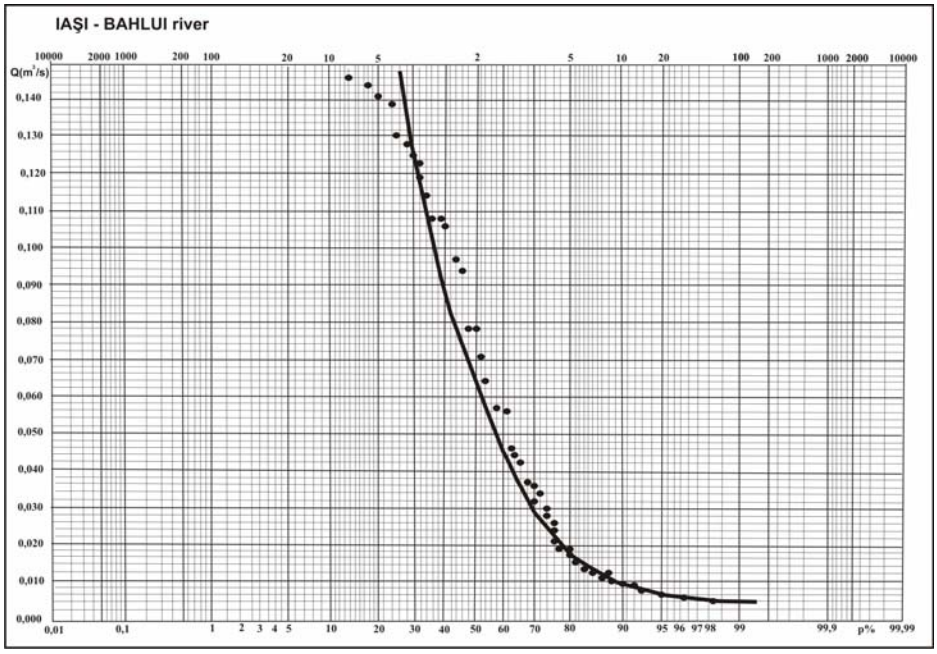

Fig.3. ***Linear normal Gauss diagrams with the mean monthly minimum discharge rates used for determining minimum discharges of different insurances at Iaşi station (on Bahlui)***

For two stations, Târgu Frumos and Iaşi (on Nicolina), the mean annual minimum discharge rates have a zero value at the 95% insurance, which indicates a quite high frequency of the river depletion phenomenon.

The variation of the mean minimum discharge rates of different insurances in relation with the mean altitude and surface of the hydrographic basins (Fig. 4.) indicates two tendencies. The first implies an increase of the values towards the west and south of the basin, at the same time with altitude, situation determined by the increase in the humidity and rainfall values.

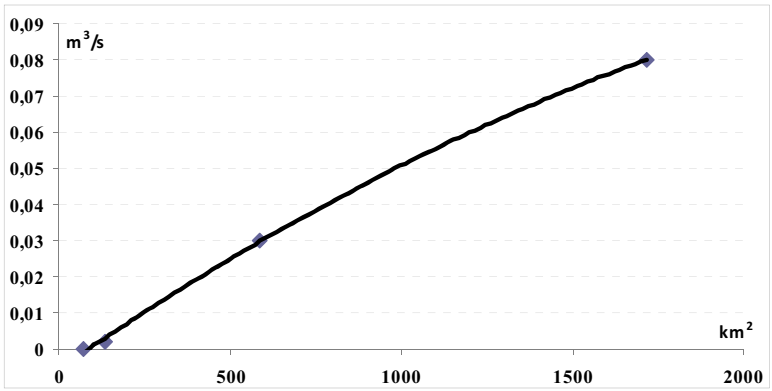

Fig.4. Variation of mean minimum discharge rates with an insurance of 95% in relation to basins' surface

The second tendency refers to an increase of the mean monthly minimum discharge rates in relation to the surface of basins (especially downstream Podu Iloaiei), determined by the water input came from used waters spills from the main towns and industrial units, and by the contribution of underground waters from terrace or floodplain alluvial deposits.

The specific minimum discharge rates with an insurance of 90% vary from 0,001 l/s/km^2 at Iaşi station (on Nicolina) and 0,160 l/s/km^2 at Iaşi station (on Bahlui).

3. CONCLUSIONS

According to our analysis, we may draw the following conclusions:

- even if Bahlui basin is over 70% hydrotechnically managed, there are concrete situations in the warm season (when the frequency of the dry or drought periods in the southern part of Jijia Hilly Plain is annual, Minea Stângă, Vasiliniuc, 2005) or the cold one when water flow on the rivers of this basin suffers an accentuated diminishment;
- in the conditions of accentuated changes in land use, the necessity of creating irrigation systems is more and more stringent, thus that an increase of the minimum discharge during the wars season is more than necessary;
- a series of hydrotechnical works created in the basin need to be reconditioned from a dimensional viewpoint, so as to take from the supplementary water input from the cold season and to use it in the warm, often deficient one.

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