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FACTORS THAT INCREASE DRYNESS PHENOMENON ON SMALL RIVERS IN PRUT BASIN (ANALYSIS OF CONDITIONALITIES)

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Key words: dryness, small basin, factors, intensity, Tinoasa, Prut.

Abstract. This study aims to analyze factors causing increased of dryness phenomenon on small rivers in Prut basin. Are analyzed, the non-climate components of the landscape (relief, geology, soil, vegetation) and climatic factors on corresponding area (rainfalls). In reporting the number of years that has occurred dryness to number of years of observations showed that the frequency of the dryness phenomenon is over 90% for basins with areas less than 5 km^2. The maximum period recorded without flow for small rivers in this basin was 292 days in 1987 on Ciurea hydrometric station closing Tinoasa catchment (A = 4.71 km^2) and 326 days on Humăria hydrometric station (A = 1.65 km^2) in the same basin. Should be noted the role of factors determine increasing phenomenon, namely geology (groundwater un-interception) and wooded areas (if smaller quantities of precipitation).

Introduction

The objective of this study is to determine the characteristics determinative factors of dryness phenomenon on small rivers in Prut basin.

For this aim Ciurea hydrometric station on Tinoasa representative basin was selected, for reasons of necessary information convenience, continuity and accessibility of data string.

Studies on minimum flow in this basin have been made by various authors over time (Chiriac, V., 1962, Pantazi, M., 1971, Păduraru, A., Popovici, V., Marţian, F., Diaconu, C., 1973 and 1974, Topor, N., 1964, Vartolomei, F., 2004, etc.) in the context of planning and economic water exploitation in this basin or to establish relations in synthetic schemes framework about hydrographic network use in Romanian Water Department, also to prepare the management Plan in Water Department Prut – Iaşi.

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1. Study area

Location and morphometric features: Prut basin is located in eastern part of Romania, the catchment area is 10,970 km^2 in Romania, and together with related areas in Ukraine and Moldova occupies 28,396 km^2 (Diaconu C., 1969).

Geological conditions: under this Prut basin overlaps three structural units: Moldavian Platform (up to fault Falciu-Plopana) Bârlad platform (between faults Fălciu-Plopana and Adjud-Oancea) and Covurlui platform, each presenting a socket covered with a folded blanket with monoclinal parties willing (Băcăuanu V. et al., 1980).

Relief: looks like a large set of inter-looking bridges, hills separated by wide valleys, carved in monoclinal sedimentary. General slope of the landscape, south-south-east, in addition to the orientation of major valleys, reflect an obvious adaptation to the structure. Monoclinal structure favored the emergence of positive and subsequent valleys. Main steps to be taken in morphology, have values of 300-500 m in the north-west, 300-400 m in the central part, 150-200 m in the north-east and south and have a relatively balanced distribution. Altitudes of 500 m are few and isolated. The lowest rates are found along the Prut river corridor (130 m on Oroftina in north, 32 m near Ungheni and less than 15 meters to the confluence with the Danube) (Băcăuanu, 1968).

Climate: due to its majority position in the extra-Carpathian regions away from the influence of Atlantic air masses, but wide open to continental air masses action from the east, north-east and north, Prut basin receives moderate quantities of precipitation. Prut Basin superimposed on the Plain of Moldavia, is directly exposed to continental air masses, the air from the west to lower the surrounding physical and geographical units frequently suffer föehn processes, precipitation is low, ranging generally around 500 mm (Radauţi 564 mm, 529.4 mm in Iaşi (Octavia Bogdan, 2007).

2. Analysis of factors that determine the intensity of dryness phenomenon in small rivers

The most important role in increasing intensity of dryness phenomenon is the natural factors which are substrate (relief, geology, soil, vegetation), on the one hand, and climatic factors on corresponding area on the other hand (rainfalls) (Păduraru A., V. Popovici, 1972).

Geology influences the amplification of phenomenon that drying up the rivers because there are often cases where the minor bed thalweg not intersect groundwater. The immediate effects are that underground supply is not permanent for surface drainage areas, this is only occurring due to precipitation fallen on the surface basins (Table 1).

Vegetation, by the most influential component of the vegetation cover, forest, influence by withholding altogether less than 15-20 mm rainfall for their falling after long periods of drought.

Tab. 1 - Physico-geographical and morphometric features of Tinoasa representative basin on Ciurea hydrometric station

River	Hydro station	Area (A în km^2)	Basin mean altitude (H in m)	Basin mean slope (I in %)	Forest coeff. (Cp in %)	Vegetation type	Soils
Humăria	Humăria	1,60	270	17,0	95,4	Deciduous forests	Red preluvosoil
Tinoasa	Ciurea	4,17	272	15,9	63,0	Deciduous forests Pastures	Tipical preluvosoil Red preluvosoil Pseudorendzine

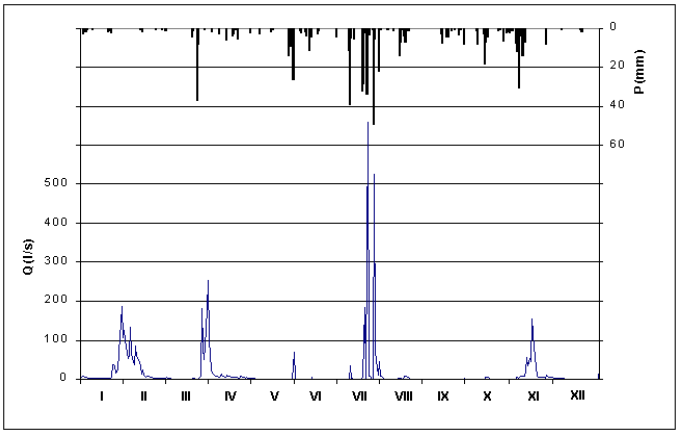

Fig. 1 - Relationship rain (precipitation layer in mm)-flow (flow in l/s) in Tinoasa experimental basin on Ciurea hydrometric station

The soil can influence the phenomenon intensity by the presence of draining gray podzolic soil containing a large percentage of clay, over 20%, and no water storage capacity that can extend drain surface.

The landscape as an physical-geographical substrate factors may influence dryness by presence of relatively small slopes of 15-17%.

Rainfall proper to excessive continental climate has annual amounts of 630 mm, but are unevenly distributed in time, with a strong torrential regime (Fig. no. 1).

3. Results and discussions

In such conditions as we mention above dryness phenomenon production rate is 40-50% for basins with an area of 15-20 km^2 and 90% for basins with areas less than 5 km^2 (Fig. no. 2).

If the Tinoasa representative basin on Ciurea flow throughout the year there was only in 1980 (the period of observation of 35 years from 1969 to 2003).

The mathematical expression of dryness frequency phenomenon is given by the function:

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

where **n** - number of years that has dryness occurred, **N** -number of observations years.

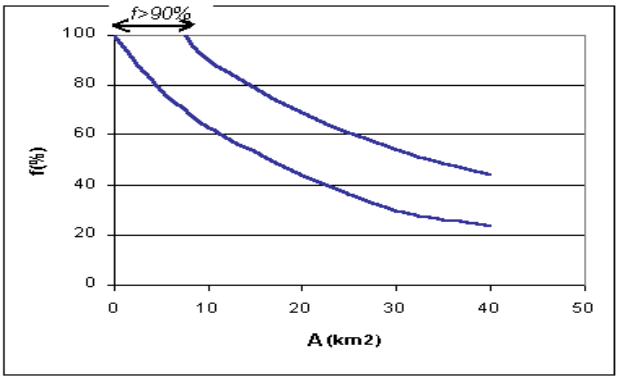

Fig. 2 - Frequency of dryness phenomenon occurrence based on catchment areas

Annual average duration of dryness phenomenon denoted by Ns (in days) has also very high values. On hydrometric station closing Tinoasa basin (area A = 4.17 km^2) Ns value is 131 days (Fig. no. 3).

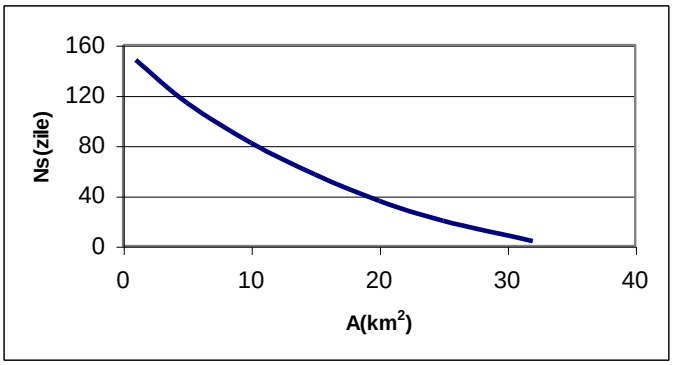

Fig. 3 - Relationship between multi-annual average duration of dryness phenomenon and basin area

The figure above shows the relationship between Ns (days) and basin area, (such as Ns = f (A)), which shows average annual duration of dryness phenomenon (ie Ns) over 120 days to areas less than 4.5 km^2.

An important phenomenon on dryness duration is distribution in time of rainfalls.

The maximum period recorded without flow for small rivers in this basin was 292 days in 1987 on closing hydrometric station in Tinoasa catchment (A = 4.71 km^2) and 326 days on Humăria hydrometric station (A = 1.65 km^2) from the same basin (Fig. no. 4).

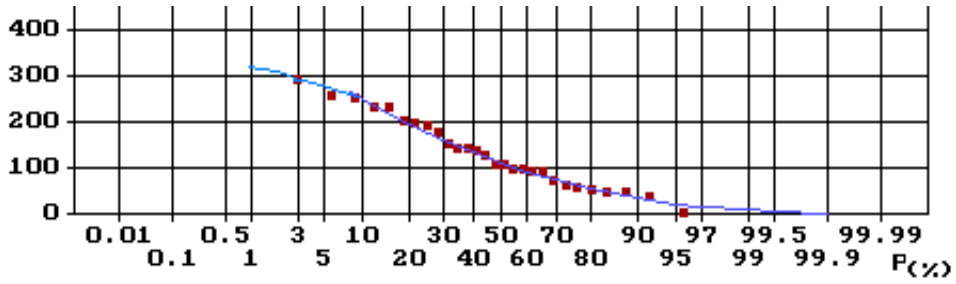

Fig. 4 - Maximum duration without registered flow probability in Tinoasa basin (on the vertical axis is the number of days without flow recorded)

Rainfalls in 1987 were 470 mm. Not the same thing happened in 1986 when they fell less precipitation - only 381 mm, less than 89 mm in 1987. However

Ns value was lower, only 255 days. This was because more precipitation fell in the spring when humidity was high and favored leakage (Fig. no. 5).

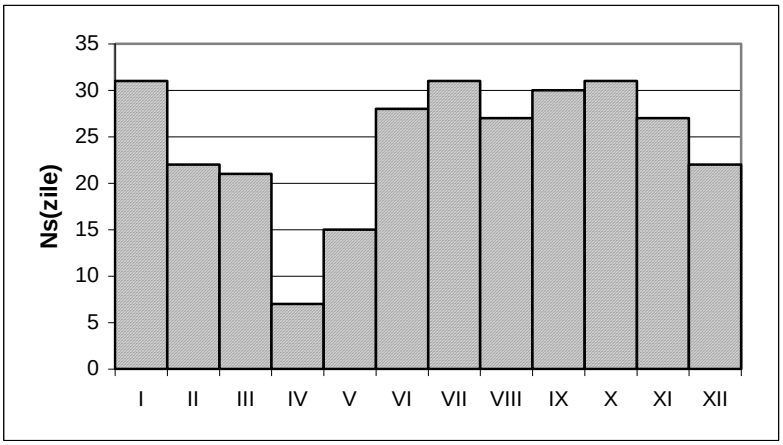

Fig. 5 - Variation in annual number of draining phenomenon days on experimentally Tinoasa basin-Ciurea hydrometric station in 1969 to 2003 period

Synthetic relationship between the maximum probability of the dryness phenomenon with 1% ($Ns_{max1\%}$) and basin area exceeding 330 days in basins with less than 5 km^2 area and more than 330 days in the basins of the same category but with high forest cover (Fig. no. 6).

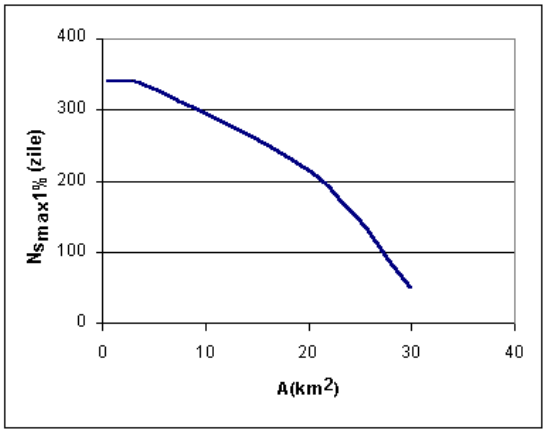

Fig. 6 - Synthesis relationship of $Ns_{max1\%} = f(A)$

For dryness mapping in Prut basin hydrographic network map was used on 1:100,000 scale, encoding streams from *Atlas of Water Cadastre in Romania*, Volume I of 1964 and maps from *Atlas of draining rivers in Romania*, scale 1:200,000, published in 1974.

To characterize the phenomenon of drying up on rivers Prut basin the following categories was established (Table no. 2):

Tab. 2 - The phenomenon of dryness for rivers in Prut basin

Dryness type	No of river segments on 1:100,000 scale (between confluences)	Total lengh of rivers (km)
draining permanent rivers	29	470
rivers with draining every year	30	22
rivers with draining every few years	35	971
rivers with rare draining	44	1381
rivers with dryness and stationary water in natural conditions	32	2
rivers with dryness and stationary water in anthropogenic conditions	30	5
rivers with dryness and water shortages in the channel in anthropogenic conditions	29	3
rivers with draining in unknown terms secării	56	464
permanent rivers	479	1601
TOTAL (including channels)	764	4919

(after Atlas of draining rivers in Romania, with additions).

-draining permanent rivers, which include rivers that flow only in high rainfall every several years;

-rivers with draining every year, which includes courses with draining appearance in every year, although in a few years from 30-40 years there has been drying up completely;

-rivers with draining every few years, which includes courses with long period draining appearance in average every 2-5 years;

-rivers with rare draining, which includes courses with long period draining appearance more once than five years;

-rivers with dryness and stationary water in natural conditions;

-rivers with dryness and stationary water in anthropogenic conditions;

-rivers with dryness and water shortages in the channel in anthropogenic conditions;

-rivers with draining in unknown terms.

It should be noted that the rivers sectors considered are appropriate to 1:100,000 scale maps, including channels identified in Prut floodplain sectors between Iaşi and Galaţi.

The base was ***Atlas of draining rivers in Romania***, by 5 partially maps related to Prut basin on 1:200,000 scale, in addition to the information which has been studying the bibliographic sources (Chiriac, V., 1962, Diaconu, C ., 1961, Mociorniţă, C., Dinca, A., Niţulescu, M., 1963, Păduraru, A., Popovici, V., Marţian, F., Diaconu, C., 1973, Topor, N., 1964).

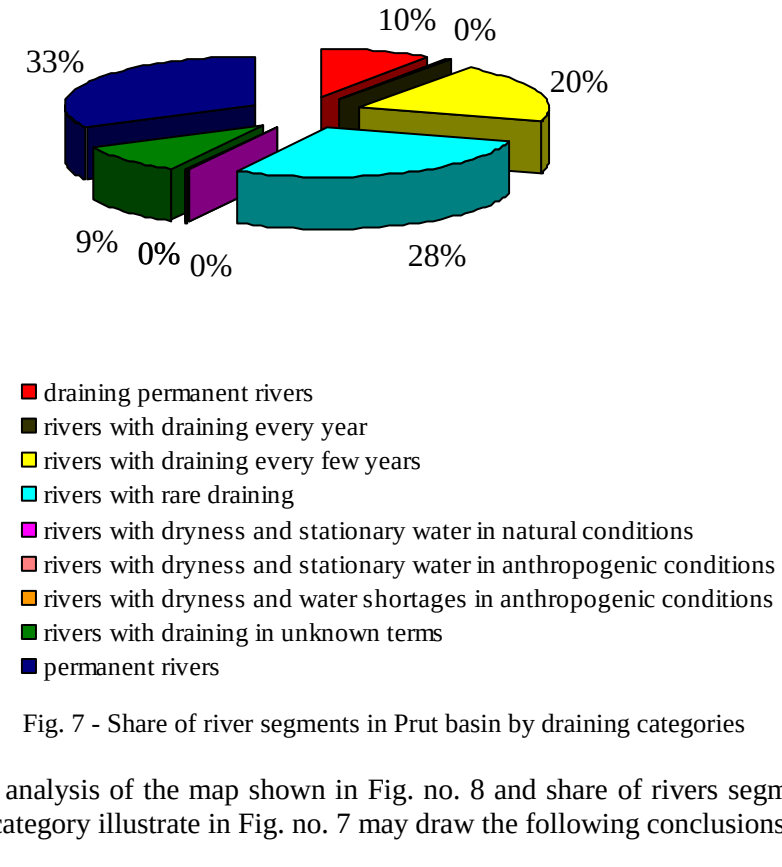

Fig. 7 - Share of river segments in Prut basin by draining categories

The analysis of the map shown in Fig. no. 8 and share of rivers segments by dryness category illustrate in Fig. no. 7 may draw the following conclusions:

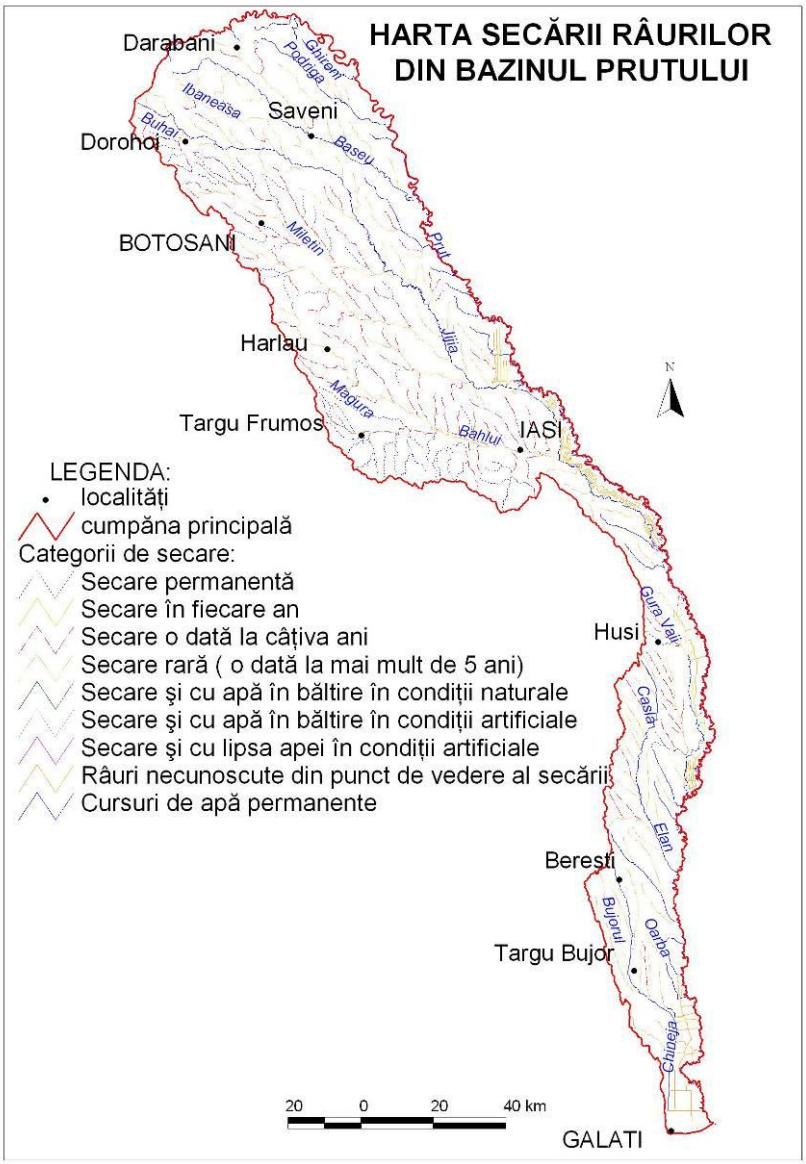

Fig. 8 - Map of draining river in Romanian sector of the Prut basin (after Atlas of draining rivers in Romania, with amendments)

-draining permanent rivers (which includes rivers that flow only in high rainfall every several years) totaling 470 km and are located mainly in the Bahlui basin, but also Sitna and Miletin;

-drying up rivers every few years (which includes courses with long period draining appearance average every 2-5 years) totaling 971 km and are characteristic of Jijia, Miletin and Sitna tributaries;

-rare-draining rivers (which includes courses with long period draining appearance, more than once every five years) account longest (1381 km), about ¼ of the length of courses in Romanian sector of the Prut basin;

-unknown rivers in draining terms including most channels, analyzed as part of the river system, located in Prut floodplain.

Conclusions

On small experimental basin can be accurate calculations and assessments about:

-multi-annual average number of days with dryness phenomenon;

-maximum number of days with draining phenomenon recorded;

-number of days with draining phenomenon by 1% probability;

-monthly maximum number of days with draining phenomenon recorded;

-appropriate probability.

Frequency of draining phenomenon production is over 90% for basins with areas less than 5 km^2. The maximum duration recorded without flow for small rivers in this basin in 1987 was 292 days on closing station hydrometric of Tinoasa catchment (A = 4.71 km^2) and 326 days on Humăria hydrometric station (A = 1.65 km^2).

Be mentioned the role of factors determining the increase of draining phenomenon, namely geology (groundwater un-interception) and wooded areas (if smaller quantities of precipitation).

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