ABSTRACT

Keywords: floods, drought, hydrological balance, dispatcher chart, drying - up phenomenon.

Since 2007, Prut River has become an objective of strategic importance because is the natural border of the European Union and NATO. Prut River between Oroftiana and Gorban has a length of 241 km and drains an area of 8020 km^2, divided as follows: 4469 in Botosani county and 3551 km^2 in Iasi.

Practical approach of hydro - climatic risks which accrue to the riparian communities using recent data (1980 - 2012), was a goal because the monitoring infrastructure of water resources is unevenly distributed across the whole basin and qualitative and quantitative properties of water record significant oscillations.

Hydro - climatic risks study is based on a set of empirical and statistical analysis of involved variables closely related with the components of natural setting: geology and geomorphology of the region, biological, climatic and pedological conditions, to which was added the increased influence of human activities.

In the catchment area, natural spatial entity, precisely delimited by the watershed, can be applied the general systems theory. The observations and measurements points (hydrometric, rainfall and hydrogeological stations) interceded quantitative determination of the input and offered the possibility to estimate the output in the closing section of the region through the mathematical relationships.

The paper aims to estimate the available volume of water in Prut River basin (the area between Oroftiana and Gorban) in the context of two risk phenomena with antagonistic traits, drought and floods and to establish some efficient management measures. The results show applicative valences and they represent the foundation of efficient management measures of the identified water resources.

Objectives:
- to identify the monthly, seasonal, annual and multianual variations which appear in the hydrological regime;

- to assess the frequency and intensity of droughts from 1980 to 2013 through the mathematical methods;
- to count the flood waves elements
- to estimate the existing volumes in Stanca - Costesti reservoir, required for the uses water supply;
- to establish some restrictions regarding the water supply during the hydrological drought;

The thesis contains 195 pages and the structure includes two parts and seven chapters.

First part, 31 % of the the work extension , comprises general considerations related to physico - geographical conditions and their role in Prut River basin water resources constitution and considers theoretical concepts of national and international literature that surprize the current state of the knowledge in risk phenomena management.

Chapter I has about 18 % of the entire work and highlight the contribution of physico - geographical factor at the constitution of water resources in Prut River basin (the area delimited by Oroftiana and Gorban).

From geologically point of view the region corresponds to Moldavian Platform, unit which represents the south - western termination of East - European (Russian) Platform. Geology exert their influence on supply surface and rocks permeability is decisive in underground aquifer layers constitution.

The area drained by Prut River delimited by Oroftiana and Gorban integrates various land forms: Moldavian Plain , Suceava and Barlad Plateau. Significant values of the altitude in the upper courses of the rivers is printed on the average altitude of their catchment areas. In west and south the „law of vertical zonality" in hydrological processes is expressed.

Soil exerts its influence on the constitution, supply and chemical composition of the surface and underground waters and also acts as a link in water cycle within the river's catchment areas. It was underlined a tiered distribution of the main soil types, nevertheless cernisoils have the highest weight. In the groundwater supply process trough infiltration and in maximum disharge constitution intercede hydro - physical properties (mainly texture).

Socio - economic activities have generated changes in the landscape due to agricultural land use or to the urbanization and industrialization action of settlements network. Division of the land use in: arable land - 45 %, pastures - 17 % and forests - 10 %, caused erosion

intensification in the case of slopes with high declivity, where soil cover is removed gradually, which increases torentiality of the rivers with small catchment areas and the solid flow.

According to the the estimates made by Water Basin Administration Prut - Barlad in the studied basin, the sectors arranged with works (embankments, regularizations and bank consolidations) measures 662 km. The embankments are 46, with a length of 467.8 km, from which 267 km on Prut River. The 80 regularizations are carried out on 360 km and bank consolidations are 105, on 52 km.

Stanca - Costesti reservoir, the most expensive hydrotechnical work in Prut River basin (5900 ha at normal level of retention) is located on the border between Romania and Moldova, in a place where the riverbed of of 3 - 4 km is strangled and reduced to 350 - 400 m highlighting the natural favorable conditions to accumulate a volume of water which can vary between 1.0 and 1.5 bln. m^3.

In the analyzed region the main climatic elements are: central and southern of Moldavian Plain is crossed by 9 °C isoterm, but values may exceed 9.5°C at altitudes below 120 m. As the altitude increases, temperature drops below 8°C to over 350 m (7.5 at Harlau).

Moldavian Plain is crossed by 500 mm isohyet in center and east, however in the high hills frame from west and south and in north may approach 560 mm (Oroftiana, Harlau). Maximum values are recorded in the summer (June and July) and reach a 39 - 45 % frequency, spring follows with 21.5 to 25.6 % and in autumn the frequency is between 18.3 % and 22.4 %. In the winter values are within the range 12.3 % to 15.9 %.

The average amount of rainfall in the warm season of the year (April to September) range between 66.5 and 72.7 of the annual and those recorded in the cold season (October to March) are within the range of 27.3 and 33.5 %.

In Prut River basin (the sector delimited by Oroftiana and Gorban), the most frequent winds are from NW, also the ones from SE intensify the evapotranspiration and contribute to minimum discharge constitution in autumn. Also, the potential evaporation is inversely proportional to altitude, values oscillating between 600 and 700 mm/year (670 at Stanca in Botosani county, during 1999 - 2011). Effective evaporation is about 500 mm, although the values grow at high altitudes due to rainfall in larger amounts, forested areas and , thus, to soil humidity.

Chapter II, with the weight of 13 % of the extension thesis refers to studies and research in Romania and other countries on risk phenomena. The documentation activity was centered on two hydro - climatic hazards: drought and floods.

Personal contributions to the field of study are presented in the second part of the thesis, which counts 134 pages, representing 69 % of the entire work.

Chapter III (9 %) highlights the purpose, objectives and methods of investigation used for the study and the samples optimal considered for the determinations.

Chapter IV - Pluviometric deficit as a risk phenomenon in Prut River basin occupies 12 % of the thesis extension and includes an analysis of drought indices variability in Prut middle floodplain and in Jijia River's catchment area.

Standardized precipitation index values between (-1.5) and (-1.0) show a 14.7 % frequency of moderate - dry periods in Prut River's floodplain. The weight of very dry years is higher in the lower bazin (6.4 % at Prisacani rainfall station) compared with the average obtained for the middle one (2.3 %) or for the entire territory of our country (4.5 % Paltineanu et al., 2007).

In agriculture the assessment of the intensity and frequency of drought which occurs in autumn, it is extremely useful. Predictive models based on the standardized precipitation index indicate that severe drought manifested from September to November, will be extended throughout the winter and the following year growing season.

The results support this hypothesis: in Prut River floodplain drought started in the autumn of 2011, was maintained during the winter and the growing season of 2012, when SPI_{6L} values ranged between (-1.5) and (-1.0) to show the moderate - dry traits of the period.

Prut River meadow is characterized by an reduced intensity of drought compared to Jijia as a consequence of the altitude, spatial distribution of the average quantities of rainfall is strongly influenced as well as the air temperature, by this parameter. Data recorded at medium altitudes that range between 500 m (Oroftiana, Radauti - Prut) and 300 m (Ungheni) showed moderate - dry or very - dry years in the middle course of the Prut River. Data analysis recorded in Jijia basin, at altitudes below 200 m, show pronounced features of droughts in the two studied years.

Chapter V represents 20 % of the work and presents elements of the average discharge and associated hydrological risks.

Multiannual average streamflow along the Prut River middle course increases from 83.7 m^3/s at Radauti - Prut hydrometric station (with a drained area of 9074 km^2), at 85.9 m^3/s and 91.9 m^3/s at Stanca - Aval and Ungheni. In the lower course, at Prisacani, where the catchment area reaches 21300 km^2 the module flow is 104 m^3/s.

Expresses as the specific average flow, multiannual average streamflow reaches values between 9.22 l/s/km^2 at upstream of Stanca - Costesti reservoir, at Radauti - Prut hydrometric station and 4.88 l/s/km^2 in the lower course at Prisacani. The supply power of the basin decreases because it includes within the limits large areas with an unfriendly climate for the discharge.

The annual drained water layer ranges between 154.15 mm at Prisacani hydrometric station and 291 mm at Radauti - Prut, where the smaller catchment area, large amounts of rainfall and the average slopes with higher values the the rest of the region allow the fast concentration of water to the riverbed.

The annual mean volume transported by the network reaches 3.28 bln m^3, the contribution of the main tributaries to establish this value, varies according to the catchment area size and the landform where they have developed the basin. Jijia with its tributaries has an intake of 449.26 mln. m^3, representing 13 % of the annual mean volumea transported by Prut River, which corresponds to the closing section of the studied region (Prisacani hydrometric station).

Across the analyzed region, average seasonal flow records the highest values in the spring (36 %), followed by the summer (28 %), winter (19 %) and autumn (17 %) and falls in the SSWA regim type.

Knowing the variation limits of the hydrological balance components established by Ujvari (1972) for different humidity regions in Romania, between Oroftiana and Gorban Prut River drains an area with deficient moisture. This is the alternation result of the years with rich or poor humidity, among the latter will predominate.

According to the module coefficient, a synthetic parameter commonly used to analyze the interannual distribution of the average flow, 2010, 2008 and 1980 were characterized by a very rich discharge, while in 1987, 1990 and 2012, rivers recorded a deficient surface runoff in the entire area. Tributaries of the first and second order have been affected by the hydrological drought also in 1983, 1995 and 2007.

Chapter VI refers to risk phenomena associated with excedentary rainfall regime and represents 10 % of the doctoral thesis.

Detailed analysis of monthly maximum flow, registered at the main hydrometric stations in the region, indicate spatial differences caused by local conditions or by pluviometric and thermal features of the periods when they were recorded. Multiannual maximum flow variability highlights the years in which the most significant values of the discharge were recorded: 1981, 1985, 1998, 2005, 2008 and 2010.

The latest floods (2008, 2010) were caused by large rainfal amounts that fell in Ukraine, in north - east Romania and Moldova. Monthly variation of Angot rainfall index indicates a seasonal growth trend in spring and summer, supraunitary values had been estimated for the interval stating to April until July, across the studied river.

Flood waves elements increase in proportional with the course length in case of Prut River and the time needed for flood mitigation oscilates between 178 hours upstream of Stanca - Costesti reservoir and 300 hours downstream. Mean value of the report G_t/T_t is between 0.30 at Rădăuți - Prut hydrometric station and 0,42 at Ungheni.

Chapter VII represents 14 % of the thesis and comprises elements of the hydrogeological regime, the main parameters specific to the piezometric drillings and the state of groundwater reserve in 2012.

In 2012 Prut River groundwater reserves have dropped with 5 - 15 % upstream of Stanca - Costesti reservoir and downstream they range between 2 - 10 %.

Depending on the daily flow values of surface discharge, registered at the main hydrometric station, it can be seen that groundwater is a permanent resource, but its contribution exceeds 20 % for Prut River, while on the tributaries, the share is below this amount.

Global climate change, coupled with pollution spread, deforestation or landscape improvement caused the enhancement of processes associated with rainfall deficiency (dryness or drought). Accordingly, the regions where drought has an endemic character, may be affected by aridity (groundwater deepening).

Thesis ends with conclusions and recommendations resulting from studies and observations on the frequency and intensity on droughts as well as the measures adopted in flood defense for the efficient management of available water volumes in Prut River basin.