Buletinul Ştiinţific al Universităţii "POLITEHNICA" din Timişoara
Seria HIDROTEHNICA
TRANSACTIONS on HYDROTECHNICS

Tom 55(69), Fascicola 2, 2010

Methods for drought and floods forecast in Jiu catchement

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Abstract: A problem of analysis and reflection in Jiu catchement is represented by both adverse effects of flooding and drought which has a high frequency. In the catchment Jiu, a problem of analysis and reflection is both a negative effects of flooding and drought phenomenon that has a high frequency, and coverage is more developed than in the rest of the country. Extreme events are controlled by monitoring progress in operational meteorological and hydrological phenomena, by strengthening the network of gauging stations equipped with both manual and automatic means of recording and transmission, to ensure daily collection of hydrological data in the basin, in order to interpret and developing their forecasts. Hydrological forecast means a planning and land use exploitation of hydro-consuming construction of water. Because the shape and size of the basin, and of training of the leak, in the Jiu river basin develop effective forecasts only on short intervals, the middle and lower sectors of Jiu, using mainly hydrological forecasting method based on levels and corresponding flow between successive gauging stations on the river sections with and without tributaries.
Keywords: forecast, drought, floods, protection, development

1. INTRODUCTION

Long regarded as a gift of nature, water is becoming increasingly one of the global problems of mankind, the rate of depletion of this resource and the negative effects of floodings is a problem of analysis and reflection on a national scale but also worldwide, whose resolution is necessary for uniting the efforts of scientists worldwide and policy makers.

The theme treated by us is to provide scientific information on extreme events of Jiu catchment area in terms of methodological approach to the study of possible future situations, for forecasting, and limiting their consequences.

Since, with physical and geographical factors (the hydrographic basin and network) the main factors determining the formation of flood waves are climatic factors (atmosfeara, thermal regime, precipitations), and the origin of most droughts reduce rainfall stays for long periods of time, forecasts are particular concern to these factors and, in this case, given the duration of phenomena, for several months, it is climate forecasts.

Modern methods of forecasting is based on analysis of the dynamics of the global climate system. Results of studies on trust climate forecasts are promising. Predictability of weather phenomena is dependent on the scale at which they manifest and theoretical results show that the phenomena characterized by large spatial scales, such as regional droughts have a greater range prediction than those occurring at smaller scales. Also, low-frequency phenomena, in which category are fall and droughts, are more predictable than high frequency phenomena such as floods.

All volume of climatological and hydrological data comes from specialized yearbooks and studies, recovered to date, belonging to the National Administration "Romanian Waters", National Institute of Hydrology and Water Management and Jiu Water National Administration.

2. THE DEVELOPMENT METHODOLOGY IN B.H. JIU FORECAST HYDROLOGY OF FLOODS

Much of the negative effects of flash flooding may be removed, if they are issued timely warnings on their production.

Hydrological forecasting has become in the last 30-35 years a modern and effective use planning hydrotechnical systems, the hydropower and hidroameliorative, the exploitation of water power, in navigation, for irrigation and fish farming and other uses of water consuming.

To conduct this work was necessary to build a strong material base, represented by a network of gauging stations equipped with means of recording and transmission, to ensure daily collection of hydrological data in the basin, in order to interpret them and develop forecasts.

In the Jiu river basin was provided as a basic material that is good insurance opportunities for daily hydrometric material necessary analysis and development forecasts. After the experimentation of various hydrological forecasting methods indicated in the literature we concluded that in this basin can be developed efficient forecasts than on the middle and lower sectors of the Jiu and only on short intervals of time, 12-24 hours.

Forecasts by longer intervals or phases of the leak, can be developed, but with lower accuracy due to oval shape and smaller size of the basin, with numerous tributaries of the course and a wide variety of training the leak.

Obtaining good results in hydrological forecasts is subject to the following:

-observations of good quality;

-perfect knowledge of local conditions on the river bottom of forecasted sector, that can influence flow forecast between two gauging stations;

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-perfect operation of the information flow between points of observations and measurements and carrying out collective forecast basin;

-immediate identification of changes in the riverbed, by raising the profile cross sections in hydrometrical gauging stations and other sections, to detect changes section of riverbed leakage or facilities that have direct influence on levels, flows and thus drained the correlations;

Correlations are shown in Fig. 1, for successive stations located on the middle and lower sector of the Jiu river, for the period immediately following the largest flood since 1972. We indicated that such correlations still involves changes of different magnitude, depending on the size of floods modifying the riverbed. They should be checked and improved after each major flood. From the presented correlations we observe that the correlation of levels between two successive stations may be form of many curves for beds with regular changes.

Critical analysis of the effectiveness of this method and the correlation itself, allowed us to see on notaries performed at the control forecast, that the results are good. Given the assessment system used in the literature (η=0,9 – good forecast; 0,8≤ η<0,9 – satisfactory forecast; 0,7≤ η<0,8 – acceptable forecast), the results η=0,91-0,95 on this river sector can be assessed as good and sometimes very good.

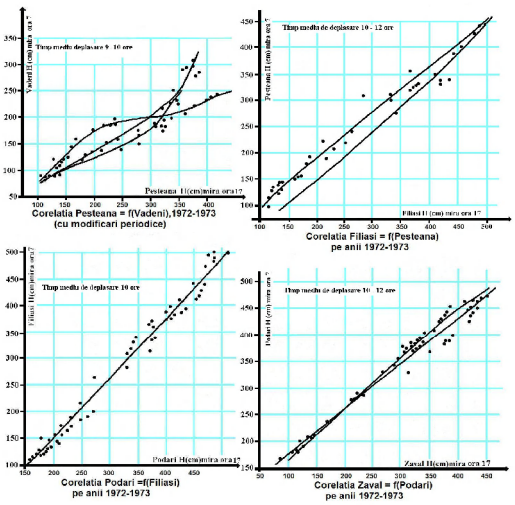

Figure 1. Correlations of levels forecast for the middle and lower sector of Jiu river – the method of corresponding levels

The same method has been tested for the forecast with three elements (triple), for the main tributary river sector (Fig. 2). Forecast results are good only in situations when the tributary lies in the synchronous phase of drainage (increase or decrease) with Jiu river or when he recorded very low flow rates, in this case the preferred method from Figure 1 with two items related.

Daily we elaborate short-term hydrological forecast on the Jiu river, on the sector Rovinari - Zaval (Danube confluence).

-continuous improvement of correlations and rating curves.

In the forecast collective we use the forecasting method based on hydrological levels and the corresponding flow between successive gauging stations, on the river sections with and without tributaries.

In this area of the river exist all the equipment for recording, measuring the hydrometrical parameters and their transmission to the forecasting team to develop hydrological warnings and forecasts.

Forecast for small and medium flow rates require special attention because at the low levels of flow the errors may be very large.

On the basis of hydrological forecasts are both the daily hydrometric information, but not at least, the statistics and correlations accumulated over 45-50 years of hydrological activities in Jiu catchment.

Permanently these statistical data, correlations, curves of barley are updated and used successfully in water management activities.

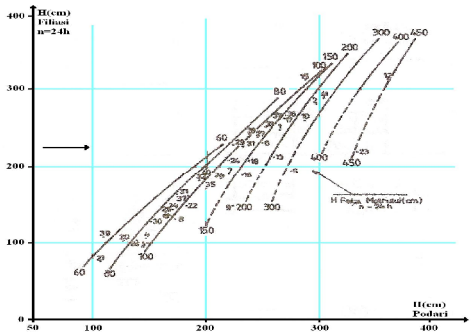

Figure 2. Graphical forecast levels for a river sector with major tributary – the method corresponding levels (with triple relation)

Currently forecasting methods are studied for the regime phases. Forecasting methods studied are based either on the laws of water motion in hydrographic network or the laws of hydrological processes occurring in river basins.

Maintenance activity with hydrological forecasts are based on the use of obtained relations from the study of methods of forecasting experience accumulated over the years by workers in this field of activity, is for extreme utility.

Forecasting methods studied and used in the activity of water management in Jiu catchment are:

- Current forecasts on short-therm on levels and flows (levels and flows corresponding method);
- Forecasting floods of rain is a method of forecasting on short-term;
- Forecast volume of spring high waters is a long-term prognosis;
- Forecasting minimum flow in summer - autumn and the date of production of such

flow. Such forecasts are generally developed after the period of spring (June);

- Forecasting date of appearance of ice bridge on a river sector, forecast that developed in the first occurrence of ice formations or as soon as there is stabilized negative air temperature at that station;
- Forecasting date of extinction of ice bridge on a river sector, forecast that once developed there is stabilization period for air heating.

Hydrological forecasts are particularly important in water management, in determining the potentially of flows and volumes on a river course in different phases of the leak.

3. ELABORATION OF FORECAST LAKES HYDROLOGY FOR RESERVOIRS

The reservoirs is most rapid and effective way to regulate the flows, so that in the water use they best meet their requirements, and to combat flooding, the reservoirs present the advantage that they can control the flood flows from concentrated.

Depending on the mode of operation meet three types of reservoirs:

- Permanent reservoirs used to ensure a minimum level of water or to satisfy consumer utilizations of water (these reservoirs are kept full, the level goes down only for the satisfaction of water users;
- Non-permanent reservoirs used for the mitigation of non-standing waves in order for the floods defense objectives (this reservoirs remain empty, in order to retain any floods);
- Mixed reservoirs (because the operating principle is completely different for the permanent and non-permanent reservoirs, and mixed reservoirs must fulfill both functions simultaneously, the volume is divided into a permanent trance and other non-permanent).

For reservoirs from this catchment area, National Institute of Hydrology and Water Management elaborates hydrological forecasts that Jiu Water Directorate use them with success in water management activities.

The main lake in b.h. Jiu whose volumes of water must be carefully managed to meet water requirement of the Jiu Valley is the Valea de Pesti lake on the Valea de Pesti river.

Experience has shown us that hydrological forecasts have important role in the operation of lakes both during periods of high water and in low water periods when volumes of water from the lake must provide water to downstream land use consumer.

Currently, we can say that due to operational exploitation hydrometry, an exploitation statute and especially in recent years due to hydrological forecasting, water requirements have been satisfied of the Jiu Valley.

Based on hydrological forecasts we can establish at any time the exploitation scenario of this reservoir for the best use of accumulated volumes and transit through the gates dam.

Valea de Pesti lake has a useful volume 3,7 mil. m^3, the main purpose is drinking water supply in the Jiu Valley, and less mitigation of flood waves.

Another weak area of river Jiu for water resources in dry periods is the river section Rovinari – Craiova.

In this area there are the biggest consumers of water, three power plants, Rovinari, Turceni, Isalnita and DOLJCHIM Craiova.

In periods of prolonged drought, flows of the river Jiu in this three sections can not satisfy water requirements for the four users.

Since 1983 was put into service, in stages, the hydropower complex Cerna-Motru-Tismana, main purpose is to provide supplementation of flows on Jiu river downstream Rovinari and also produce electricity.

The practice has proved that no supplement can provide water flow would cover the Jiu water scarcity on the consumer great utilizations.

It is known that hydroelectric plants works only in periods when consumption is high and as such used water flows are intermittently pulsed into the River Jiu.

Using hydrological forecasts and specific scenarios of exploitation both for the hydropower complex Cerna-Motru-Tismana and for the lakes on Jiu river, is offered at any time necessary flows for the users downstream Rovinari.

Using hydrological forecasts can increase the efficiency of hydrotechnical facilities in various stages of leaching, is formed only after a certain conception of typical exploitation of the lakes, which are determined based on a set of operating policies.

In developing these policies of exploitation will take into account: type lake reservoir, exploitation restrictions, targets of exploitation, use full of volumes protection against floods, how training and composition of flood waves in river basin, the flood level in the lake at the end of flood will have to tend to the normal retention level, having regard to the possibility of successive floods.

Based on hydrological forecasting in various stages of river leakage for each lake must be developed operational scenarios that holders will observe rather.

These operational scenarios are the rules for optimal and efficient exploitation of reservoirs on the river to meet water management policies in a catchment.

For a catchment with a high degree of planning with lakes, outlets and derivatives, the degree of accuracy increases because a part of forecasted flow on a sector of river, known as the flow crossed the reservoir, is only estimated flow from the difference of catchment. Hydrotechnical fitting of the Jiu River

is one way to ensure the flow of water for the user, but is not enough. For better management of water resources so as to satisfy all users must be developed long-term hydrological forecasts, medium and short term, they followed by the rules and regulations in each phase of the leakage with all users.

Permanently should be prepared hydrological forecasts for the whole catchment and sub-basins but also on each reservoir making analysis depending the projected climate change.

Droughts, although less spectacular than flash floods, the other extreme in waters life, yet they exert pressure and more long-term effects, on human life and material goods, effects that are just as damaging, if not more damaging by lack of water.

New trends in water resources management system for periods of minimum hydrological regim require rethinking of strategies to address this area taking into account that the phenomenon of drought is not a non-combatant, but for this it is necessary progress in water resources management, through operational monitoring weather and water phenomena.

In Jiu hydrographical basin, the phenomenon of drought has a higher frequency and scope of a much more developed than in the rest of the country. There was a strong tendency to decrease in average river flows, the volumes of water from lakes and accumulation, with negative implications for consumer satisfaction. There are areas from Getic Piedmont and Oltenia Plain, which dries almost every year (Amaradia, Hunşiţa, etc).

The phenomenon of drought is a consequence of developments in rainfall regime, and it's depend by these climatic conditions. If Jiu river basin, precipitation deficit particularly affecting its south, and rises in dry years, at least 200-300 mm.

Although the phenomenon of drought can't be controlled, instead can be tackle the effects of drought and draining rivers, to the extent they exist and operate optimally, accumulation of water made for this purpose and large irrigation systems (like those from Oltenia Plain) and locals locale, able to compensate the deficit of moisture in this part of the country. Complex reservoirs are the main defense against floods, but also constitutes and water sources for population, industry, fishery and irrigation. These measures concerning the organization and general and local economic opportunities. The activity of water management has carefully many negative implications of these phenomena in the economy.

In current practice of water management, it occupies an important place the characterization schemes using water resources and establish the circumstances to be applied in meeting the requirements of water restrictions. Plans for water use restrictions and for the periods of temporary restriction on water use, cover the temporary restriction in situations when the water flows authorized objective reasons can't be provided to all users. The period of applicability is 5 years, current plans are for the 2006-2010 restriction.

4. MONITORING AND MANAGEMENT OF DROUGHTS IN JIU CATCHEMENT

The problem of water deficiency, in fact the management of droughts, are hot topics, while watching to find relevant answers to questions raised by the integration of Romania into the European Union. Droughts and water deficiency are not new, but they increased in frequency and intensity in recent years.

In the Water Jiu Directorate area it was selected the users which have covered this issue in terms of quantity and quality, but according to sources of the flow rates from examined sector.

Required flow rates were based on statistical studies for units with low consumption and based on volume - water delivery subscription for 2006.

Submit appropriate documentation analysis system for early reporting of cases of restrictions on information, which includes:

- water resources parameters in terms of quantity and quality;
- water requirements;
- water management facilities.

The plan itself contains restrictions:

- restricted water use and degree of impairment of water supply;
- powers conferred water management bodies in such situations;
- measures for users;
- a collaboration mode;
- records, measures and ways of cooperation during the restrictions;
- how to record the end of the period.

The analysis system for reporting cases of restrictions

Analysis for reporting cases of restrictions involving a systematic cooperation between units of water management, water users and a proper system of accounting and reporting in the regimes of water management and water direction, with their transmission to the National Administration "Romanian Waters".

Jiu Water Directorate seeks continuous improvement and the qualitative aspect of the natural flow of water in sections of control via gauging stations and the Laboratory of Hydrochemistry and Hydrobiology. Also follow the water requirements of the beneficiaries.

For the application of the plan of water use restrictions and for the periods of temporary restriction compared characteristic flows to meet water users in control sections of source flows.

For characterization of water resources, has been made an analysis of hydrometric stations and hydrologic data collected and stored within our unit. In Jiu hydrographical basin are installed in 69 hydrometric stations, with measurements of levels and discharges, of which 37 are with daily transmission.

By the 11 based gauging stations are controlled the 9 sectors on the river Jiu contained in the restrictions plan. In choosing control sections were

considered as the criterion for their placement, to be upstream to important intakes for water users at administrative districts limits. For the all catchment were selected 9 areas, 5 of sectors on the Jiu river, 1 sector on the river Gilort, 1 sector on the river Motru 1 sector on Jiu de Est River and 1 sector on Tismana river, numbers work sectors making traversing the river basin downstream to upstream. (Tab.1)

Table 1. River sectors covered in plan of restriction

River sector	River	Lenght (km)	Control gauging station
Zăval-Podari	Jiu	76	Podari
Podari-Filiaşi	Jiu	63	Răcari
Filiaşi-Rovinari	Jiu	74	Rovinari
Rovinari-Iscroni	Jiu	66	Iscroni-Livezeni
Iscroni-Câmpu lui Neag	Jiu de Vest	28	Bărbăteni
Livezeni-Lonea	Jiu de Est	15	Lonea
Câlnic-Arjoci	Tismana-Orlea	13	Godineşti-Celei
Turburea-Novaci	Gilort	76	Tg.Cărbuneşti
Faţa Motrului-Cloşani	Motru	75	Târmigani

Determination of minimum required flow in control sections was performed as follows:

Minimum required quantitative flow (QN) was determined analytically and graphically in each control section to meet from quantitative point of view of the minimum requirements water for users on sectors being located immediately downstream of that section and to ensure healthy flowin in river bed.

Minimum required flow for ensuring the quality (Q NPCA) To define the conditions for satisfy the quality requirements of water users were determined the minimum flow values of water courses, in sections in which respect the acceptable limits of quality indicators. These discharges were determined taking into account the size and composition of discharges upstream water users and the phenomenon of Self-purification, to ensure by dilution not exceeded concentrations for downstream water users.

Table 2. Discharges necessary for water user in summer and winter period

River sector	River	summer			winter		
		Q AT (m^3/s)	Q N (m^3/s)	Q NPCA (m^3/s)	Q AT (m^3/s)	Q N (m^3/s)	Q NPCA (m^3/s)
Zăval-Podari	Jiu	1,300	1,000	10,45	1,300	1,000	10,45
Podari-Filiaşi	Jiu	6,866	5,282	8,050	6,640	5,108	8,050
Filiaşi-Rovinari	Jiu	8,804	6,773	7,100	8,804	6,773	7,100
Rovinari-Iscroni	Jiu	1,388	1,068	3,200	1,131	0,870	3,200
Iscroni-Câmpul lui Neag	Jiu de Vest	1,290	0,993	1,300	1,583	1,217	1,300
Livezeni-Lonea	Jiu de Est	0,617	0,475	1,100	1,300	1,000	1,100
Câlnic-Arjoci	Tismana-Orlea	1,355	1,043	0,270	0,494	0,380	0,270
Faţa Motrului-Cloşani	Motru	0,260	0,200	0,350	0,260	0,200	0,350
Turburea-Novaci	Gilort	0,260	0,200	0,500	0,260	0,200	0,500

The phenomenon of drought, in whatever form, is a complex phenomenon and it is generated by some specific climatic and petrography-lithography conditions of the river and river bad, in Jiu basin. Against the territorial hydrographic distribution of rivers and stations under observation number, we appreciate the necessary and sufficient to continue to keep these sections. All data volume (expeditionary and direct) is satisfactory at this stage and allowed a synthesis characterization in this study.

The development of Romanian society by shifting industry and agriculture to a market economy, expansion of centralized water supply for the improvement of comfort, requires judicious management of water resources.

The main role of the present generation is the sustainable management and rational and balanced distribution of water resources while maintaining quality and ensuring their natural regeneration. Regarding to this, it is necessary clear and permanent records of resources (operating reserves) in the region, on the one hand, and its volume flow operating on the other.

That's why it is to develop specific forecasts on rivers barley during periods of drought, using a computer program. Development and improvement of such a program of barley rivers forecasting, it is extremely beneficial for crucial economic activities like:

- water supply of some localities from rivers affected by barley (eg: Tg. Jiu – spring alimentation and Jaleş riverin Runcu section);
- local irrigation (on many medium and small rivers);
- the qualitative and quantitative management (monitoring) of some polluted rivers (Amaradia - Hurezani and its tributaries, Cioiana etc.) with petroleum products (dilution capacity changes depending on the rivers flow);
- evolution of water volumes in accumulations and in rivers affected by droughts (superior Jiu river - for Valea de Peşti reservoir).

5. DESWAT PROJECT IMPLEMENTATION IN JIU WATER DIRECTORATE

In the context of the damage to our country by extreme floods in a severe drought fund generates annual losses of millions of dollars to reduce the investment of such damage is a priority for policy action by the Ministry of Environment, which is according also with recommendations of the

Parliament Directive and European Council regarding to the framework for communication to the field of water action establishment.

To achieve this objective, the Ministry of Environment is considering a strategy for needed investment in water management and implementation of integrated water information system throughout the country, to prevent and mitigate the effects of disasters. DESWAT Project (Water Destructive abatement and Control of Water Disasters) aims to end the current modernization hydrological

Within Jiu Water Directorate were proposed to install 74 stations, of which 57 are gauging stations and 17 rain stations. From all the 57 gauging stations has dropped to 164 Jiet AHSS (due to lack of radio signal), 71 stations were built and 23 stations of these with solar energy supply in use.

The ultimate goal of this project is to modernize existing hydrological monitoring networks in Romania, using the latest technology and new products for information / appropriate alarm of public for floods.

DESWAT project realization will help cover a wide range of applications, with obvious economic advantages:

- anticipation of floods production and areas likely to be flooded;
- anticipation of chemical pollutants dispersion in the aquatic environment;
- anticipate of the production of severe minimum flow that would affect water supply services;
- anticipating of extreme flows and volumes for good management of large accumulations;
- commercial applications (maps of areas in which forecast exceeds the alert levels, telephone service with hydrological information, products for television) which will bring profit by charges both to INHGA/ANM and National Administration Romanian Waters.

Implementing this program in Jiu catchment is advanced following that other projects and programs will be promoted and implemented to prevent and mitigate the effects of extreme hydro-meteorological phenomena.

monitoring networks in Romania, using the latest technology and creating information products / alarm adequate public disclosure if dangerous phenomena.

By implementing of DESWAT project at Jiu Water Directorate's level, the hydrology activity and water management will enter into a new and modern stage of development and modernization of river monitoring system and forecasting. Its main objectives are to improve capacity, speed and accuracy of forecasting, and assessment of potential damages in case of flooding.

6. CONCLUSION

Hydrological forecasts are more useful in water management during high water and flash floods, when based on them should be taken measures to mitigate the damage that may occur.

The phenomenon of drought cannot be contained, instead its effects can be controlled through judicious management of water resources, according to the organization and general and local economic opportunities, in that purpose is useful to develop specific forecasts on rivers in drought periods.

Hydrological forecasts help us to use wisely and effectively volumetric capacity of the reservoirs both during periods of high water and periods of drought.

Also, new schemes must be thought of basin planning guidelines in view of climate forecasts and extreme events in Jiu hydrographical basin occurred in the last decade.

Daily short-term forecasts should be developed and updated the medium and long term depending on weather forecasts.

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