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# ON REGULATION REGIME FUNCTION OF A RESERVOIR

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## ABSTRACT

Reservoirs are the most effective way of regulating streams flows. The inflow process, the reservoir storage and the outflow processes together constitute the streamflow regulation system. The three important variables in this system are - reservoir storage capacity, yield of the reservoir and some reliability characteristics. They are related by the regulation regime function. One way of determining the exact shape of regulation regime function is through simulation.

In the present paper regulation regime curves have been developed for the Sabarmati river at Dharoi. The monthly stream flows for Sabarmati river have been used for this purpose and the annual reliability is used as the reliability characteristic. The regime function is very useful in gaining insight of the regulation problem.

## INTRODUCTION

The storage reservoirs are the most effective way of regulating natural flow of a stream. The reliability of getting a prespecified amount of release mainly depends upon, inter alia, the storage capacity of the reservoir. The higher is the storage capacity, higher is the reliability of supplying a given amount of water or higher will be the yield for a specified reliability. This is so because reservoir basically provides storage space to carry inflows from excess to deficit period. The study of storage-reliability-yield relationship is essential to provide preliminary estimates of design capacity or yield of a reservoir. This relationship relates the inflow characteristics, reservoir capacity, release and reliability. This analysis is the main aim of the stochastic theory of storage. The methods used to perform storage-yield analysis can be broadly classified into sequential and non-sequential methods. Between the two, the sequential methods, which make use of historical inflow series are more popular; the most common example being mass curve method. The simulation analysis is another technique which is rapidly coming up partly because of wider availability of computers.

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## REGULATION REGIME FUNCTION

The inflow process, the reservoir storage and the outflow process, constitute the streamflow regulation system. The operation regime of this system is specified by the storage capacity of the reservoir (S), yield (q) and a measure of reliability of the reservoir (R). The relationship among these three variables can be symbolically designated by a function [Klemes,1981].

$$\phi = \phi\,(S, q, R) \qquad \ldots\ldots(1)$$

where $S > 0$

$q > 0$

$0 < R \leqslant 100\ \%$

Any two of these three variables can be regarded as independent and the third one following the appropriate functional form :

$$S = S(q, R) \qquad \ldots\ldots(2a)$$

$$q = q(S, R) \qquad \ldots\ldots(2b)$$

$$R = R(S, q) \qquad \ldots\ldots(2c)$$

He pointed out that the available methods of stochastic storage theory can directly handle only equation (2c). Equation (2a) and (2b) can be solved only for the finite deterministic inflow series and R = 100 % with the aid of mass curve method. The nature and shape of the regime function obviously depend upon the statistical properties of inflow series. The shape also depends upon the length of time period used in analysis. The required storage size reduces with increase in time period because of averaging out of fluctuations. The storage capacity arrived at using the mean annual flows is termed as long-term storage and the one using mean monthly (or of durations of same order) gives a very close estimate of storage capacity required to meet the given demands. Seasonal storage is the difference of these two storage terms.

## DEVELOPMENT OF COMPONENTS OF REGIME FUNCTION

As pointed out earlier iterative search using simulation approach is best suited for developing different components of regime function or determining the value of third variable knowing the other two. A computer programme has been developed and reported by Vaghe and Jain (1987). This programme has been developed to find either minimum storage required to meet given demands or to determine the maximum possible firm yield from an existing storage, both at the specified reliability level. The programme has been described in detail in the above referred report.

## A CASE STUDY FOR DHAROI RESERVOIR

The different components of regulation regime function for Dharoi Reservoir on river Sabarmati located in Gujarat State have been developed, Inflow data for a continuous period of 400 months was available for this reservoir and used in analysis. The development of programme and all computations were performed on VAX-11/780 Computer of NIH.

The results of analysis have been presented in graphical forms in Figures 1, 2 and 3 which correspond to equations (2 a), (2 b) and (2 c) respectively. For ease of interpretation, the yield is expressed as a ratio of mean inflow in which case it is termed as degree of regulation. Similarly, the storage capacity is also expressed as a ratio of mean annual inflow total and can be termed as storage ratio. For the Dharoi reservoir, the mean annual inflow total works out to be $86.808 \times 10^7$ cubic meter. A distribution of yield among different months was adopted based upon the irrigation demands. It is readily apparent from the Figure 1 that the value of the reservoir yield decreases repidly with increase in reliability measure R. Similarly, the Figure 2 shows that after a certain limit, the marginal requirement of storage space for small increases in storage required are quite large, more so for smallar values of yield. In other words, it means that smaller degree of regulation for the reservoir can be obtained with quite small storage ratio.

## CONCLUSION

The various components of regulation regime have been described. These components for Dharoi reservoir in Gujarat State have been developed and presented. The computations were performed using a generalized programme developed at NIH, Roorkee, From the graphs prepared, it is immediately clear that from the basin small values of yield can be obtained even with quite small storage.

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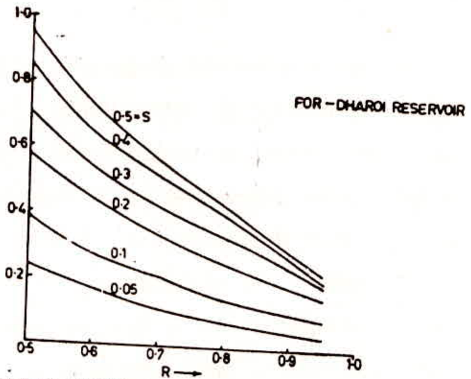

FOR – DHAROI RESERVOIR

FIG. 1. S=S (q, R) STORAGE AS A FUNCTION OF DRAFT AND RELIABILITY

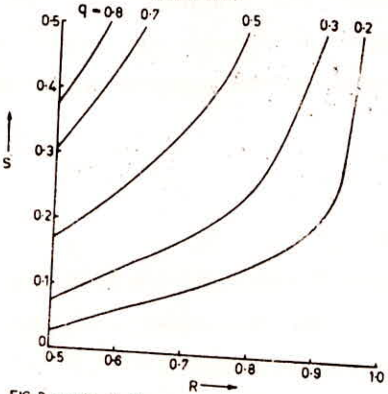

FIG. 2. q=q (S, R) DRAFT AS A FUNCTION OF STORAGE AND RELIABILITY

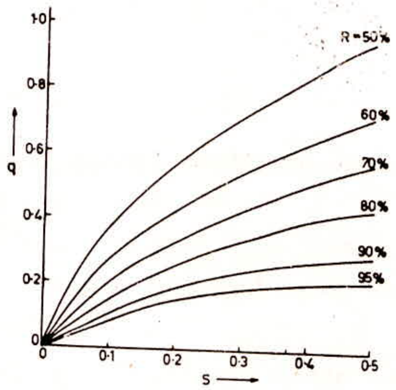

FIG. 3. R=R (S, q) RELIABILITY AS A FUNCTION OF DRAFT AND STORAGE