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MODEL OF FUNCTIONING OF WATER-MANAGEMENT SYSTEM WITH ONE WATER BASIN OF COMPLEX FUNCTION

Presented by Member of Academy Z.TaTashidze May 15 2005
BULLETIN of the Georgian Academy of Sciences, 172, #3. pp. 499-501.

abstract: The model of calculation for the balance of water-management beneath a water basin has been created. The model enables calculating water balance not only at the separate river sites, but also at the whole territory of water-management system.

Key words: Calculation of water-management balance.

For imitation of functioning of water-management system with one water basin, which is located on the main river with various water-consumers and effecting regulation of drain, the model providing calculation of water-management balance below a water basin has been created.

The main question solved in this case is the establishment for each time interval the quantity of the water subjected to recovery from a water basin for the sake of providing water-consumers with water demand.

The used method has enabled calculation of water balance not by sites of the river, but in each point of water-management system.

The calculation of the balance in a point is reduced to comparison of total requirements of the water-consumers, accumulated in the result of consecutive calculation of balance in all previous points of the scheme. In the result, the new value of total requirements, and also the size of spillover equal to surplus of water, which has not been used by consumers situated beneath is defined.

The operation of a water basin should be made under dispatching rules, which will cause water delivery for each time interval depending on water stocks.

The volume of water x_{ji}, which the water-consumer j in an interval of time i can receive from a water basin, depends on an arrangement of this interval in an annual cycle (t) and replenishment of a water basin. It is established in the form of:

$$x_{ji} = f(T, Z, N) \qquad (1)$$

where x_{ji} is recovery; T is time; Z is a mark of a water basin, N is a norm of water supply to the water consumer j, depending on values Z and T.

The balance equation of a water basin in i-interval of time looks like:

$$\Delta W_i = \sum_{j=1}^{i} Q_{ji} - \sum_{k=1}^{m} P_{ki} - \sum_{n=1}^{t} \pi_{ni} \ , \qquad (2)$$

wherein: ΔW_i is a change of a water basin volume;

$\sum_{j=1}^{i} Q_{ji}$ is a total inflow to a water basin in i- interval;

$\sum_{k=1}^{m} P_{ki}$ is a total recovery of a water basin;

$\sum_{n=1}^{t} \pi_{ni}$ is total losses from a water basin

.The value of a total inflow to a water basin $\sum_{j=1}^{i} Q_{ji}$ when making calculations on long-term rows is preset for each i–interval.

The value of a total recovery of a water basin $\sum_{k=1}^{m} P_{ki}$ is designed depending on the initial mark of a water basin in i–interval and is corrected depending on the value of the final mark of a water basin.

The value of total losses from a water basin $\sum_{n=1}^{t} \pi_{ni}$ is designed depending on the initial and the final marks of a water basin in i–interval.

The equation (2) is designed by progressive approximation. The balance equation can be recorded like this:

$$\mathrm{DP} = \sum \mathrm{Q}_{\mathrm{j}} - \sum P_k - \sum \Pi_n + (W_{нач} - W_{кон}), \qquad (3)$$

wherein: index i is ommited, and Winit и Wfin are the volumes of a water basin, corresponding Zinit and Zfin, DP is estimated imbalance.

Further such value of $\sum P_k$ is picked up, under which $DP-\varepsilon=0$, wherein ε- is an accuracy of calculation.

As a result, the matrix is defined characterizing a condition of water-consumers receiving water from a water basin in a calculated interval i, where m- is a number of the consumers receiving water from a water basin.

When solving the equation (3) the final mark of a water basin is defined by the coordination of water output from a water basin with a matrix of a mode of components (mx_j). The matrix can be changed for the same dispatching schedule.

The described model is realized in the form of programs system and used for carrying out of scientific researches of water-management calculations.

As a result of calculations per interval there are defined:

- a final mark of filling a water basin;
- charges in the bottom volume;
- average capacity per interval and development of electric power;
- precarious volumes.

The mode of distribution of water resources during the periods of floods should provide observance of a guarantee mode of water-delivery by performing the required values of calculated probability in a long-term view.

For the description of a predicted drain the probabilistic mathematical model has been used, which is based on a composition of distribution, constructed on the basis of correlation between uniformly distributed random variables expressing the probabilities of excess of hydrological characteristics.

If the mistake of the prediction (Δx) is subordinated to normal distribution with an average equal to zero and density

$$P_i(x)=\frac{1}{\sqrt{2\pi}}e^{-\frac{x^2}{2}}, \tag{4}$$

and predictable tributary $(W_a=y)$ is subordinated to three-parameter gamma- distribution with parameters Y_0,∂,b and density

$$P_2(y)=\left[\frac{\Gamma(\partial+\mathrm{b}}{\Gamma(\partial)}\right]^{\partial/\mathrm{b}}\bullet\frac{1}{\Gamma(\partial)\gamma_0}\left(\frac{\gamma}{\gamma_0}\right)^{\partial/\mathrm{b}-1}\varepsilon x\rho\left[-\frac{\gamma}{\gamma_0}\frac{\Gamma(\partial+\mathrm{b})}{\Gamma(\partial)}\right]^{1/\mathrm{b}}, \tag{5}$$

then the conditional size of distribution of prediction mistake x at a predicted drain y is equal to:

$$\phi(x/y)=P_1(x)\left\{1+b\lambda\phi(x)\left[2F_1(x)-1\right]+5\lambda^2\left[b\phi^2(x)-\tfrac{1}{2}\right]\left[bF_2^2(y)-bF_2(y)+1\right]\right\}, \tag{6}$$

wherein $F(y)$ is a tabulated value of the function of three-parameter distribution.

At calculations on the basis of rows of observable drains with a view of reception of stable results, it is necessary to construct some rows of predicted sizes W_a and mistakes of prediction Δ. In this case, probabilistic characteristics of functioning of water-management system are defined as averages for every generated row.

Imitating experiments according to efficiency of the hydrological prediction for management were spent for a conditional average forthcoming drain, and quantiles of 10, 25, 75 and 90 percents provision of a conditional curve of mistakes of the prediction.

The conducted researches show that long-term hydrological predictions are rather essential reserve for increase of a management efficiency of complex water-economic systems.

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