WATER MANAGEMENT MODEL IN A HYDROLOGICAL BASIN

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Abstract: The concept of water management can be used successfully in the design and operation of different structures of the hydraulic structure. It can also be used to estimate the present and the future water availability in different regions.
An efficient production of electrical energy is an actual national and international problem, under the circumstance of an "hungry" energy production wished it to be produced under the follow condition: "*higher production and low costs"*. One of the disadvantage in the production of electrical energy using hydropower plants reside in wrong exploitation and surveillance of the lake with inerent consequncence: material losses, inflows.

Keywords: management, model, water, hydro-potential

1. INTRODUCTION

Water resources being unevenly distributed, the purpose of a dam is to create a storage of the water coming from upstream and optimize its discharge according to the various needs downstream for domestic, industrial, as well for environmental protection. But the purpose could be the management of storage capacity to absorb possible flood excess and mitigate the potential damage downstream.

Reservoirs store water at times when streamflow is ample, and supply water in times when streamflow is scarce. The overall purpose of reservoirs is straightforward, but can be obscured by the many competing interests that exist in river basins. Reservoir operation policy must balance these goals.

The purposes of Reservoir are:

- to provide flood protection,
- to provide water for irrigation and/or water supply
- to generate hydropower

2. WATER MANAGEMENT

Water management model compute flows, levels, water quality, and other parameters based upon physical laws and conceptual relationships. The models are calibrated by comparing computed results to observed values with subsequent adjustments to mathematical coefficients to attain closer agreement. The models are verified by comparing historical events not used in the calibration to computed results.

Application of hydrologic simulation model to a watershed requires three types of data:

- several years of daily or hourly meteorological data
- several years of daily streamflow data for model calibration
- physical data describing the land surface, river channels, and reservoirs or lakes.

Short term forecasts of streamflow or reservoir inflows are used to schedule hydropower production or instream flow releases and to operate diversion structures for irrigation and municipal water supplies. During floods, forecasts based on quantitative precipitation forecasts (QPFs), help schedule reservoir releases from spillway gates.

Short term forecasts, for future periods of a few days to one week, are dependent on the current watershed state and short term meteorological forecasts.

Long term forecasts of streamflow or reservoir inflows are probabilistic or stochastic. They depend on the current conditions in the watershed and on future weather. Future weather is unpredictable, but using historic meteorological data as alternate future weather sequences, it determines probability distributions of future streamflows and reservoir inflows.

A mathematical model represents transpositions of a data set or information to another data set related by mathematical relations. The transfer function will determine the model:

$$h = f_1(V);\ V = f_1(h) \quad (1)$$

- volume of water and his height are related;

$$E_S = f_2\,[V] \quad (2)$$

- the energy produced on a certian water volume [GWh / 1mil.m^3];

$$P_E = f_3\,[h] \quad (3)$$

- the potential si also related with the water volume.

Forecasts are made for an outnumber of probabilities for a wide range of variables, including reservoir or lake levels, cumulative water deliveries, hydropower production, spill, and water supply deficits.

3. MODEL DESCRIPTION

3.1. Prerequisite

Model Components are: Land Segments, River Reaches, Reservoirs, Aquifer Elements, Meteorological Stations.

A land segment is a subdivision of the watershed, consisting of an area or areas with homogeneous hydrologic characteristics, such as mean annual precipitation, soils and vegetation cover. Land segments are represented by a set of parameters. Some of these parameters can be determined from known watershed characteristics, either by measurement or by estimation. Other parameters must be determined by calibration, that is, by fitting computed hydrographs to the observed hydrographs.

Simulation of the flow in the rivers is done by dividing the stream channel network into a number of reaches. A reach is represented by an element situated between two points. The cross section, slope and roughness within a reach are constant. Channel reach parameters represent the physical characteristics of each reach. The flow through the reach is assumed to be unidirectional. Each channel reach may receive inflow from several different land segments and from upstream reaches and reservoirs.

All inflows to the reach (local runoff, flow from upstream reaches, etc.) are summed and enter the element without distinction as to location of entry. The outflow may be distributed across several targets, to represent normal outflow and diversions. Depth and velocity of flow in each channel reach in each time step are related to channel reach characteristics using the Chezy-Manning equation. Continuity of flow volumes is maintained.

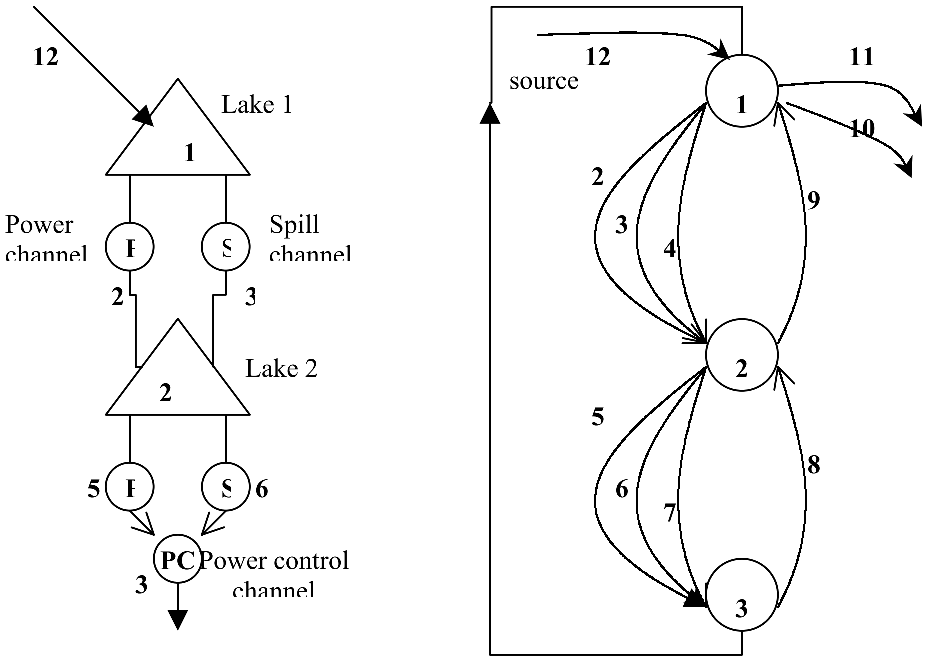

Figure 1: Schematic and graph representation of the model

The main components represented are
- reservoir nodes(a)
- junction nodes(b)
- channels(c)
- Power stations (d)
- Structures (e)

(a)Reservoir elements include natural lakes and controlled reservoirs. The outflow from natural lakes is controlled by the geometry of the outlet channel. The basic parameters used to describe a 'standard' lake or reservoir are: stage-storage curve, bottom elevation and elevation of the overflow spillway or natural outlet

(b) Junction nodes are similar to reservoir nodes in that they combine a number of inflow and outflow channels in the network

(c) Channel reach parameters describe the slope, roughness, and cross-section of the incised channel and flood plain. Precipitation and evaporation from the surface of channel reaches are considered.

(d) Hydroelectric power stations are a combination of a two channel: a power channel and a spill channel.

(e) Structures are different types of channels to describe other types of channel

The model calculates inflows into and outflows from the reservoirs. For reservoirs that have demand time series, the model also determines: volume and elevation in the reservoir, power generation, spill, flow through each outlet and deficit. Each outlet and spillway can be represented in detail, including hydraulic capacities and physical characteristics of gates. Additionally, the model can be customized to automatically operate the reservoir taking into account rule curves for flood control purposes, minimum flow requirements downstream and any other restrictions.

The continuity equation that determines the water balance in a region within a specific interval:

$$DV = I - O \qquad (4)$$

in which DV is the increase in the volume of water in the region, I is the water volume that enters the region, and O is the water volume that goes out, all within the interval Dt, can be applied to the watershed as follows:

$$V_{t+1} = V_t + V_a + V_m + V_p + V_v + V_i - E_t - V_g - V_u - V_d - V_e \qquad (5)$$

where: V_t = volume in watershed at the beginning of the month
V_{t+1} = volume in watershed at the end of the month
V_a = direct inflow to watershed
V_m = transfer from other regions to watershed
V_p = precipitation's volume on the surface
V_v = precipitation's volume in watershed
V_i = volume of extraction from the aquifer
E_t = evaporation loss volume
V_g = transfer in downstream watershed
V_u = demand for use in hydropower
V_d = surplus volume in watershed
V_e = transfer from watershed to other regions

3.2. Working with the model

There are three types of demand associated with a controlled reservoir: Low Level Outlet Demand, Power House Demand and Diversion Demand. Water released to meet the Low Level Outlet Demand and the Power House Demand continue downstream. Water released to meet the Diversion Demand is lost to the system. Reservoir demands can be specified as time series of flows.

Dynamic Reservoir Operation means taking the current watershed state into consideration when making operational decisions. The watershed state changes, so operational decisions that are based on watershed state also change - they are dynamic.

Static Reservoir Operation means making decisions to release water from the reservoir without using any information about the watershed state. Static operations follow a rule curve.

Policy Parameters control the operation of the reservoir, that determines when water is released from the reservoir and when water is stored by specifying values for a set of "policy parameters".

3.2.1. Choosing dynamic operation policy parameters

The definitions of the policy parameters are:

- Reservoir storage, working full pool volume: The maximum capacity of the reservoir under normal conditions

- Probability of exceeding working full pool: The units are percent, and the range of acceptable values is 5 to 95.
- Reservoir storage, working minimum pool volume: The minimum capacity of the reservoir under normal conditions.
- Probability of remaining above the working minimum pool: The units are percent, and the range of acceptable values is 5 to 95.

3.2.2 Choosing Static Operation Policy Parameters

The first two parameters are the same as for dynamic operation:

- Reservoir storage, working full pool volume: The maximum capacity of the reservoir under normal conditions.
- Reservoir storage, working minimum pool volume: The minimum capacity of the reservoir, under normal conditions.

The other two parameters tell how to follow the rule curve. If the reservoir storage falls below the rule curve, less essential demands will not be met. There are seven beneficial uses of water, and they are ranked in decreasing order of priority.

Release Rank Above Rule Curve: When the reservoir volume is above the rule curve, water will be released to meet the demands up to this ranking number.
Release Rank Below Rule Curve: When the reservoir volume is below the rule curve, water will be released for demands up to this ranking number.

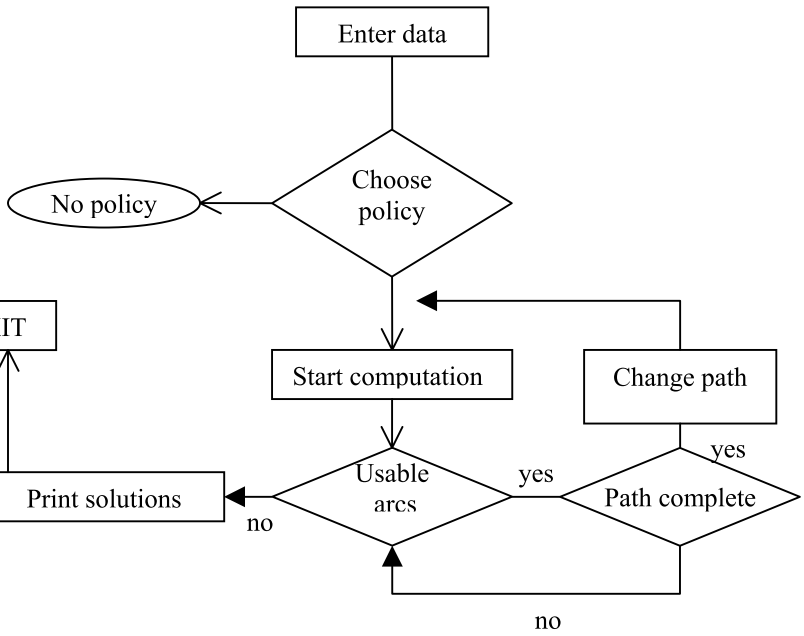

Figure2: Simplified scheme for policy computation

4. CONCLUSIONS

The study of water balance within a watershed is complex, but at the same time it is very important since appropriate decisions have to be made for the rational planning and management of water, as well as its use by the various sectors.

To simplify the problem, only mean water balance for one-month would be considered, without taking into account the storage facilities that can be used to cover critical months, or even years.

The study is developed in the frame of ***"Interactive Telematic System for Hydroelectric Power Potential of a Hidroenergetical Reservoir"***, financed by INFOSOC Romanian National Research & Development Program

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