DEVELOPING A WATER SUPPLY/WATER QUALITY GUIDE CURVE FOR LAKE SIDNEY LANIER

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Abstract. A simple numerical routing technique can be applied to develop a guide curve for the operation of a storage reservoir during multi-year droughts. This intuitive technique can be derived from past drought data to show when water releases from the lake should be limited to water supply and water quality alone. The technique was applied to Lake Lanier at present day levels of water demand using period- of-record droughts.

INTRODUCTION

Much analysis of water quantity management with reservoirs is accomplished with simulation tools such as HEC-5. These tools have the advantage of being able to show cause/effect relationships throughout a river basin and for long hydrologic records. Because of the wide spread availability and intuitive nature of simulation tools, often other simple, analytical techniques have disappeared from use.

GUIDE CURVE TECHNIQUE

One such technique is that historically used to determine reservoir guide (or rule) curves. There have been other guide curves in history of Lake Lanier operations. An early curve whose basis is unknown was a guide to providing firm power. The water control plan developed in the late 1980's designated zones which were intended to preserve "balance" among all project pools while serving multi-purpose objectives. The technique described herein is an objective analysis to provide a time-sequence of reservoir levels below which it is prudent to only provide the minimum flow or yield.

The first step in the process is to identify the most critical point of a drought/low flow sequence. In the case of an existing reservoir the observed lowest point of drawdown is usually a good indication of the beginning month or the most critical month of a low-flow drought sequence. It may be useful to begin the analysis described below at several time steps before or after the apparent critical month to insure the most critical point is selected. For a prospective reservoir a mass plot, such as first demonstrated by Rippl(1883) can be used to readily identify critical dry periods

There are three data items needed to develop a conservation yield guide curve. An elevation-water storage relationship is needed for an existing or prospective reservoir. The desired or required outflow is needed. This can be either a single yield value or it may be seasonally variable to correspond to seasonally varied water supply demand. In this example we are using monthly water demand values for the present Lake Lanier water quality/water supply for Lake Lanier shown in Table 1. The water demands are a significant determinant in the analysis. The greater the demand the more water storage must be retained to augment natural flow in the droughts.

The third data item is inflow sequences—preferably as long a record as possible. In the example case we used the "unimpaired" flow data sequence developed in the Apalachicola- Chattahoochee-Flint Comprehensive Study (Corps, 1996). This 55 year period contained the early and late 1980's droughts.

Table 1. Lanier Water Demands

	Evaporation*	Lake Withdrawal	River Withdrawal	W.Q. Flow	MGD Total	Loss & Reguired Release, CFS
J	-	91 (MGD)	97**	485	673	1040
F	-	91	97**	485	673	1040
M	-	91	97**	485	673	1040
A	-	112	129**	485	726	1123
M	101	117	325	485	1028	1591
J	107	144	350	485	1086	1674
J	109	154	400	485	1148	1776
A	96	154	400	485	1135	1756
S	81	134	370	485	1070	1655
O	60	126	350	485	1021	1580
N	36	106	325	485	952	1474
D	24	91	300	485	900	1393

* Evaporation rates from unimpaired flow studies applied to pool area at 1045.
** Additional withdrawals provided by flow from area between Lake Lanier and Atlanta.

The procedure for developing the guide curve can be described as "backwards-routing". One presumes the reservoir would be empty or reaches lowest acceptable level at the most critical point in the drought. Using the continuity principal a reservoir level is computed moving back in time steps using the equation:

$S_i=S_{i+1}+O_I-I_i$

Where S Reservoir storage at beginning of period.

S_{i+1} - Reservoir storage at end of period.

O_i - Outflow in period.

I_i - Inflow in period.

Since reservoir level is a function of storage, the series of storages may be converted to a time series of reservoir levels.

Past drought years of the 1980's were evaluated for Lake Lanier using this process. Since critical periods for Lake Lanier stretch over several years several drought year sequences were used. The results of these routings are shown in Figure 1.

An envelop curve can be developed from these "routings". Figure 2 shows two year drought guide curves. The significance of the upper curve is that if the reservoir level is at or above the elevations shown on this curve and minimum releases/withdrawals are made the reservoir level will remain at or above the minimum target level with the repeat of the input drought sequence and will reach the minimum reservoir level in the second year. The lower curve represents the case in which the reservoir could be depleted in one year. Figure 3 represents these curves on a single year. They could be used to guide water conservation or restricting reservoir releases.

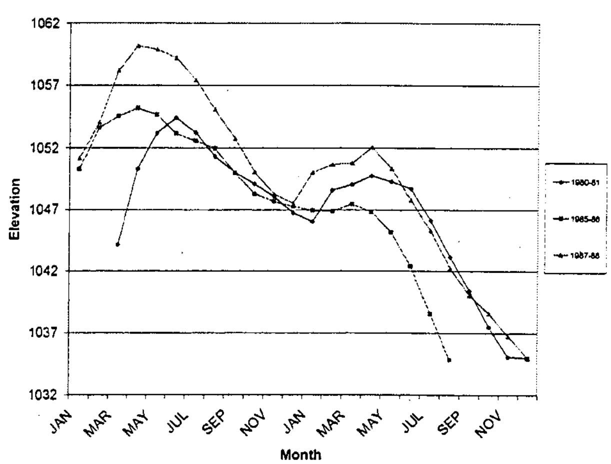

Figure 1. Three previous droughts.

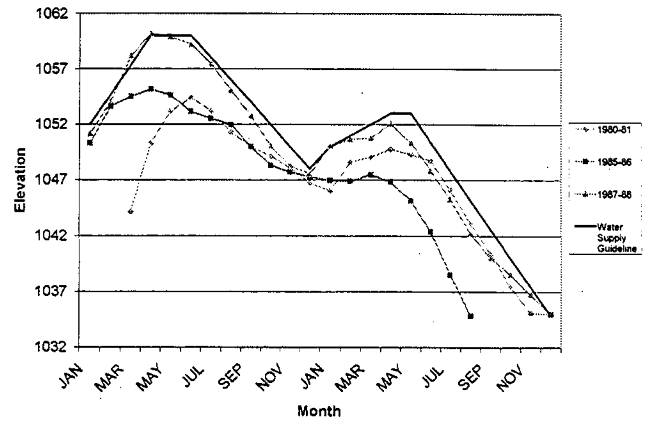

Figure 2. Guide curve envelope.

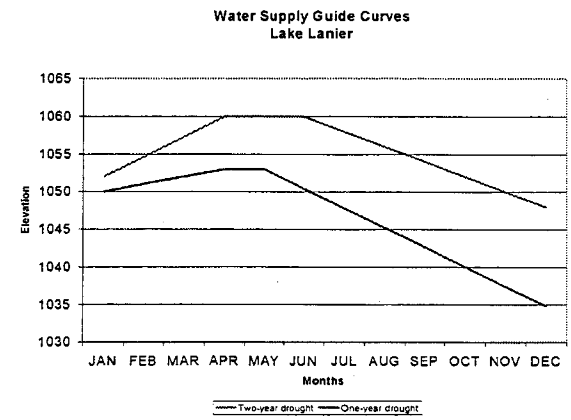

Figure 3. One and two-year drought guides.

CONCLUSION

Guide curves based on previous droughts offer a useful tool in guiding water supply usage as well as serving to guide reservoir releases.

REFERENCES

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