

CE EN 431
Engineering Hydrology
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Section 1

Lab 5: Evaporation from Lakes & Reservoirs--Palisades Dam, Snake River, ID

Submitted to:
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Introduction

The purpose of this report is to provide evaporation and TDS concentration data for Palisades reservoir. In this lab, I determined the monthly evaporation, the monthly total dissolved solids (TDS) concentration, and the yearly average TDS concentration out of the Palisades reservoir in 1963.

The Palisades reservoir is located on the Snake River in Idaho. I have acquired the following data about the Palisades reservoir:

Storage capacity: 1,420,000 acre-feet

Surface area: 16,100 acres

Height of dam: 270 feet

Elevation of crest: 5630 feet

Latitude: 43 degrees, 20 minutes north

The Palisades Dam is a rock-faced, earth-fill dam that began preliminary construction in 1945 and was completed in 1957. The dam contains 13,571,000 cubic yards of material. At the time of construction, this was the largest volume of material placed in a dam by the Bureau of Reclamation.

The Palisades reservoir has many benefits. The water from the dam is used for irrigation, flood control, and recreation in eastern Idaho. In addition, the dam provides substantial flood control benefits.

Objectives/Procedure

For the objectives and procedure, I have included the lab handout. You can find the lab handout in the appendix.

Results

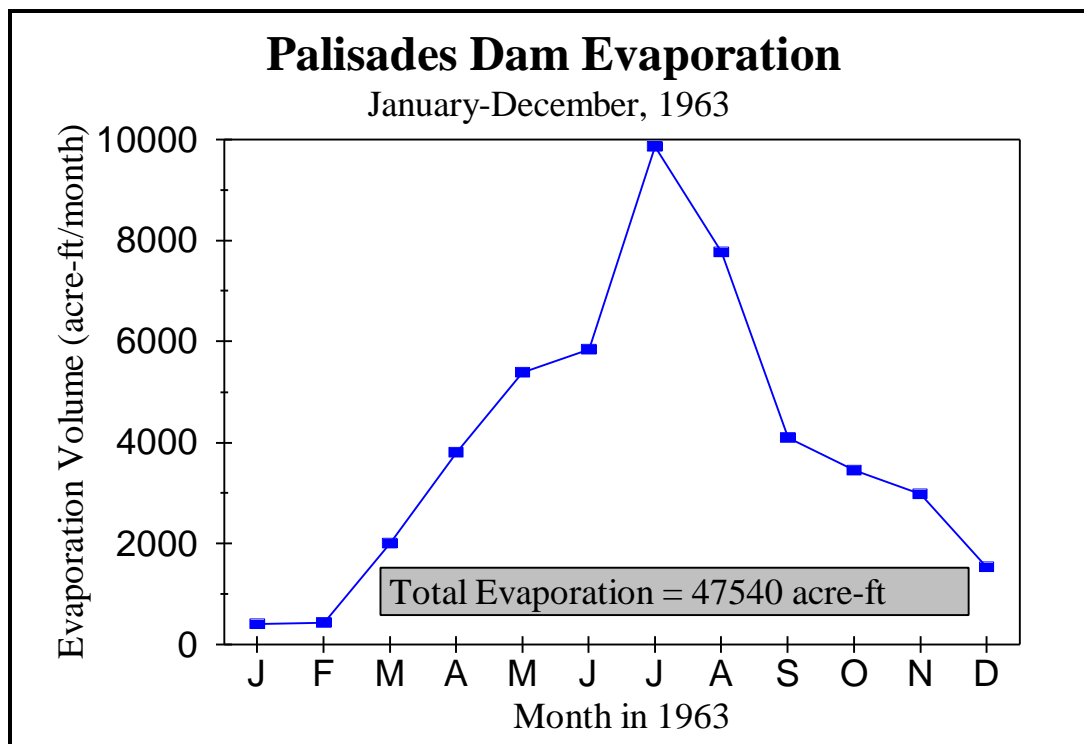


Figure 1: Evaporation volume per month from the Palisades reservoir in 1963.

Table 1: Palisades reservoir evaporation in acre-ft and inches per month, 1963.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acre-ft	405	426	1995	3803	5931	5833	9857	7773	4097	3444	2980	1535
Inches of depth	.35	.35	1.58	2.8	4.0	1.2	8.3	7.2	4.0	3.4	2.8	1.4

Table 2: Palisades reservoir outlet TDS concentration, 1963.

Month (in 1963)	Outflow Conc. (ppm)
January	400.04
February	400.04
March	400.18
April	400.35
May	400.49
June	400.53
July	400.93
August	400.76
September	400.41
October	400.34
November	400.29
December	400.15

Annual average TDS concentration (1963): **400.38 ppm out of the reservoir**

Average percent increase through the reservoir (1963): **0.094%**

Discussion

The lab results are located in figure 1 and in tables 1 and 2.

Evaporation data. The amount of evaporation in Palisades reservoir in 1963 is located in figure 1 and table 1. During the winter months, very little evaporation occurred. But during the summer months, almost 10,000 acre-ft of water evaporated from the reservoir every month. This lowered the depth of the entire reservoir by almost 8.5 inches.

However, compared with the flow through the outlet of the reservoir, there was very little evaporation. The total flow through the outlet of the reservoir was over 4 million acre-feet per month. This was much more flow than the 10 thousand acre-ft of evaporation per month.

TDS concentration data. I found the annual average outlet TDS concentration in the Palisades reservoir to be 400.38 ppm. This is a 0.094% increase from the 400 ppm that entered the reservoir. 0.094% seems to be a small increase in TDS concentration through the reservoir, but I have checked my calculations and they seem correct. Also, *most* of the evaporation and TDS increase in the reservoir are caused by diverting the water from the reservoir for irrigation.

During the summer months, when more evaporation occurred, there was a slightly higher TDS concentration in the reservoir effluent. This makes sense, since more water evaporates during the summer, leaving slightly less water leaving the reservoir and a slightly higher concentration of dissolved solids.

The spreadsheet calculations for the TDS concentration leaving the reservoir are located in appendix C: calculations.

Calculations

The calculations were fairly straightforward and involved calculating the reservoir evaporation from the pan evaporation, finding the area and discharge in the reservoir, and performing unit conversions. I followed the following steps to perform my calculations:

- I found the reservoir evaporation in inches by using the following equation:

$$E_L = p_c E_p$$

where E_L is the lake evaporation, p_c is the pan coefficient (assumed to be 0.7 for this lab, but not usually), and E_p is the pan evaporation.

- Then, I found the average reservoir contents for every month, in acre-ft.
- Next, I used the area-capacity-discharge curve to find the average reservoir area each month.
- Using the average reservoir area, I calculated the evaporation volume, in acre-feet.

- I used the area-capacity-discharge curve to find the discharge through the outlet. Since Palisades reservoir had two outlets, I used both outlet curves on the area-capacity-discharge curve and added the discharges together.

- I converted the outlet flows from cfs to acre-feet per month. For example:

$$\left(71000 \frac{ft^3}{s}\right) \left(3600 \frac{s}{hr}\right) \left(24 \frac{h}{day}\right) \left(30 \frac{days}{month}\right) \left(\frac{1 acre}{43560 ft^3}\right) = 4,224,800 \frac{acre-ft}{month}$$

- I then computed the reservoir inflow using:

$$Q_{in} = Q_{out} + Q_{evap}$$

where Q is the flow in acre-ft/month.

- Finally, I calculated the outflow concentration for every month using:

$$C_{out} = \frac{Q_{in} C_{in}}{Q_{out}}$$

where C stands for the concentration.

- Using the monthly outflow concentrations from 1963, I calculated the average outflow concentration for the year and the percent increase in outflow concentration for the year (compared to an inflow concentration of 400 ppm).

Conclusions/Applications

In conclusion, a hydrologist must look to many sources to obtain the volume of evaporation from a reservoir. Among the required data are the standard pan evaporation near the reservoir, the water levels of the reservoir at various times, and the area-capacity-discharge curve for the reservoir. If hydrologists or environmental engineers need to determine the TDS concentration in the water leaving the reservoir, they must also determine the original TDS concentration in the river.

In this study of the Palisades reservoir, I discovered that there is very little change in the TDS concentration through the reservoir. The evaporation rate is small compared with the total flow of water through the reservoir. But when the water is used for irrigation and there are many reservoirs along a river, the TDS content in the downstream waters will be higher than if the river is left alone.

Among the applications of evaporation data are the following:

- When preparing environmental impact statements for a reservoir, it is necessary to determine the impact of the reservoir on the river. Using the evaporation data from a reservoir, a hydrologist can determine the theoretical TDS concentration in the water flowing out of the reservoir.
- Hydrologists can determine how much water will be available for use from a reservoir using evaporation data from the reservoir and a water budget on the reservoir.

Appendix

Appendix A: References

- Wanielista, Martin. **Hydrology and Water Quantity Control**. John Wiley and Sons, Inc. 1990.
- United States Department of Commerce, Weather Bureau. **Climatological Data, 1963**. Printed by the United States Government Printing Office in 1963.
- United States Department of Interior, Geological Survey. **Water Supply Papers**.
- United States Department of Interior, Bureau of Reclamation. **Reclamation Project Data, 1981**.--I used this to get information about the construction and dimensions of the Palisades reservoir.

The lab handout and my calculations are located on the following pages.

Appendix B: Lab Handout

Appendix C: Calculations and Data