Kelsey Burrell
Lab 11
ENGR 115
10 Nov. 2016

On November 3rd, 2016, our Introduction to Engineering class visited the Fern Lake reservoir at Humboldt State University. Designating the reservoir as our system boundary, we collected data and performed a water balance.

We measured the rate of inflow to the system using two methods. First, we obtained the velocity of the inflow using a stopwatch in conjunction with a float. The velocity was then measured using a flow velocity gauge. We used a measuring tape to obtain the dimensions of a cross-sectional area of the inflow stream in order to calculate the total volume rate of inflow.

We measured the outflow rate using a stopwatch to determine the time it took to collect five gallons of the water.

Each experimental procedure was conducted three times, and the results were averaged. The data analysis, results, and error analysis are located on the proceeding sheets.

Assumptions

1. There was no groundwater infiltration into or out of the reservoir.
2. There was no runoff from the watershed into the reservoir.
3. The fish hatchery was not extracting water from the reservoir.
4. There was no evapotranspiration activity within the reservoir boundary.
5. The evaporation rate from the reservoir was equal to the pan evaporation rate located in the National Weather Service's historical data (for Ferndale in the month of November), multiplied by 0.7. This data is over four decades old.
6. We were able to collect the total outflow volume.

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Input Parameters	
Area of lake (km^2)	0.008
Area of lake (m^2)	8000
Pan Evaporation Rate (in/November)	1.04
Lake Evaporation Rate (m/November)	0.0185

Conversion factors	
in/m	39.37
m/km	1000
m/cm	0.01
m/ft	0.305
s/hr	3600
m^3/gal	0.00379
hr/November	720
Area of lake/area of pan (m^2)	636.9

Float

Inflow method 1	Depth (cm)	Depth (m)	Width (cm)	Width (m)	Length (m)	Volume (m^3)	Time (s)	Time (hr)	Flowrate (m^3/hr)
trial 1	5.1	0.051	44	0.44	1.1	0.025	4.21	0.0012	21.11
trial 2	5.1	0.051	44	0.44	1.1	0.025	4.37	0.0012	20.33
trial 3	5.1	0.051	44	0.44	1.1	0.025	5.28	0.0015	16.83
								Average Flowrate (m^3/hr)	19.42

Velocity Meter

Infolw method 2	Depth (cm)	Depth (m)	Width (cm)	Width (m)	Cross Area (m^2)	Meter Value (ft/s)	Meter Value (m/s)	Flowrate (m^3/hr)
trial1	5.2	0.052	43	0.43	0.022	0.5	0.152	12.27
trial2	6.5	0.065	42	0.42	0.027	0.5	0.152	14.98
trial3	5.2	0.052	43	0.43	0.022	0.5	0.152	12.27
							Average Flowrate (m^3/hr)	13.17

Bucket Method

Outflow Method 1	Bucket Volume (gal)	Bucket Volume (m^3)	Time (s)	Time(hr)	Flowrate (m^3/hr)
trial 1	5	0.019	19	0.0053	3.59
trial2	5	0.019	17.59	0.0049	3.87
trial3	5	0.019	17.34	0.0048	3.93
				Average Flowrate (m^3/hr)	3.80

Average Inflow (m^3/hr)	16.30
Average Outflow (m^3/hr)	4.00
Accumulation (m^3/hr)	12.30
Change in Depth (cm/hr)	0.15

Fern Lake was not in a steady state when we collected our data. The reservoir was filling at a rate of about 12.3 m^3/hr, and the height of the body of water was changing at a rate of about 0.15 cm/hr.

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Conversion factors	
in/m	39.37
m/km	1000
m/cm	0.01
m/ft	0.304878049
s/hr	3600
m^3/gal	0.003785413
hr/November	720

Our length measurements were the most inaccurate source of data for inflow method 1. The float traveled farther than we measured since it did not follow a straight path, and our measuring device was straight. For our outflow method, the total volume collected was the most inaccurate source of data.
There was definitely volume loss due to our collection method.

When I reduced these values to 10% lower than measured, the total accumulation in the lake was about 0.6 m^3/hr lower, and there was no change in the rate of depth increase. I do not believe these calculations reflect the physical conditions of our data collection.

When I increased these values to 10% higher than measured, the total accumulation in the lake was about 0.6 m^3/hr higher, and the change in height increased by 0.01 cm/hr. The latter is negligible given the precision of our measurement devices. I think the values resulting from these calculations more accurately reflect the actual processes in the lake (for reasons stated above), and have left them in this version of

Input Parameters	
Area of lake (km^2)	0.008
Area of lake (m^2)	8000
Pan Evaporation Rate (in/November)	1.04
Lake Evaporation Rate (m/November)	0.018491237

Float									
Inflow method 1	Depth (cm)	Depth (m)	Width (cm)	Width (m)	Length (m)	Volume (m^3)	Time (s)	Time (hr)	Flowrate (m^3/hr)
trial 1	5.1	0.051	44	0.44	1.21	0.027	4.21	0.0012	23.22
trial 2	5.1	0.051	44	0.44	1.21	0.027	4.37	0.0012	22.37
trial 3	5.1	0.051	44	0.44	1.21	0.027	5.28	0.0015	18.51
								Average Flowrate (m^3/hr)	21.37

Velocity Meter								
Infolw method 2	Depth (cm)	Depth (m)	Width (cm)	Width (m)	Cross Area (m^2)	Meter Value (ft/s)	Meter Value (m/s)	Flowrate (m^3/hr)
trial1	5.2	0.052	43	0.43	0.022	0.5	0.152	12.27
trial2	6.5	0.065	42	0.42	0.027	0.5	0.152	14.98
trial3	5.2	0.052	43	0.43	0.022	0.5	0.152	12.27
							Average Flowrate (m^3/hr)	13.17

Bucket Method					
Outflow Method 1	Bucket Volume (gal)	Bucket Volume (m^3)	Time (s)	Time(hr)	Flowrate (m^3/hr)
trial 1	5.5	0.021	19	0.0053	3.94
trial2	5.5	0.021	17.59	0.0049	4.26
trial3	5.5	0.021	17.34	0.0048	4.32
				Average Flowrate (m^3/hr)	4.18

Average Inflow (m^3/hr)	17.27
Average Outflow (m^3/hr)	4.38
Accumulation (m^3/hr)	12.89
Change in Depth (cm/hr)	0.16

Results without accounting for error:
Fern Lake was not in a steady state when we collected our data. The reservoir was filling at a rate of about 12.3 m^3/hr, and the height of the body of water was changing at a rate of about 0.15 cm/hr.