

Belle Ciotti

Engr 115

Fern Lake Water Balance

The following analysis was created by taking inflow and outflow measurements of Fern Lake on the HSU campus. The analysis performed shows that the lake is not in steady state and estimates by how much the lake is filling up by.

Belle Ciotti
Engr 115
11/4/2016
Friday Afternoon Lab

Conversion Units
1in=0.0254m
1ft=0.3048m
1hr=3600sec
1gal= 0.00378541m3
1Nov=720hr
Pan Evap= .7Lake Evap
1m=100cm

Input Parameters	
Surface Area Lake (m ²)	8000
Pan Evaporation (in/Nov)	1.04

Float Inflow Method 1	Depth (in)	Depth (m)	Width (in)	Width (m)	Length (ft)	Length (m)	volume (m ³)	Time (sec)	Time (hr)	Flowrate(m ³ /hr)
	1	0.03	14	0.4	8	2.4	0.02	18	0.005	4.5
	1	0.03	14	0.4	8	2.4	0.02	18	0.005	4.3
	1	0.03	14	0.4	8	2.4	0.02	19	0.005	4.1
Avg Flow Rate										4.3

Velocity Meter Inflow Method 2	Depth (in)	Depth (m)	Width (in)	Width (m)	Channel area(m ²)	Meter value (ft/s)	Meter value (m/s)	Meter Value (m/hr)	Flow Rate (m ³ /hr)
	2.5	0.06	9	0.23	0.014	0.7	0.21	768	11.1
	2.5	0.06	9	0.23	0.014	0.6	0.18	658	9.5
	2.5	0.06	9	0.23	0.014	0.8	0.24	878	12.7
Avg Flow Rate									11.1

Bucket Outflow Method 1	Bucket volume (gal)	Bucket volume (m ³)	Time (s)	Time (hr)	Flowrate (m ³ /hr)
	5	0.02	45	0.01	1.5
	5	0.02	46	0.01	1.5
	5	0.02	46	0.01	1.5
Avg Flow Rate					1.5

Outflow Recorded Data	(in/Nov)	Lake Evap (in/Nov)	Lake Evap (m/Nov)	Lake Evap (m/hr)	Lake SA (m ²)	Lake Evap (m ³ /hr)
Evaporation	1.04	0.7	0.02	2.6E-05	8000	0.2

Results	(m ³ /hr)
Inflow Avg Method 1	4.3
Inflow Avg Method 2	11.1
Avg Inflow Both Methods	7.7
Avg Outflow Method 1	1.5
Recorded Lake Evap	0.2
Total Outflow (Avg Outflow + Recorded Lake Evap)	1.7

	Avg Inflow (m ³ /hr)	Total Outflow (m ³ /hr)	Accumulation (m ³ /hr)
Water Balance Rate Result			
Accumulation=In-Out	7.7	1.7	6.0

Accumulation is not equal to zero so the lake is not in equilibrium. Furthermore the accumulation is positive so the lake is filling up.
The lake is filling up at a rate of 6m3/hr.

Depth Change Rate	Accumulation (m ³ /hr)	Lake SA (m ²)	Depth Change (m/hr)	Depth Change (cm/hr)
	6.0	8000	0.001	0.07

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1in=0.0254m
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1gal=0.00378541m ³
1Nov=720hr
Pan Evap=.7Lake Evap
1m=100cm

Input Parameters	
Surface Area Lake (m ²)	8000
Pan Evaporation (in/Nov)	1.04

Float Inflow Method 1	Depth (in)	Depth (m)	Width (in)	Width (m)	Length (ft)	Length (m)	volume (m ³)	Time (sec)	Time (hr)	Flowrate(m ³ /hr)
	0.9	0.02	14	0.4	8	2.4	0.02	18	0.005	4.0
	0.9	0.02	14	0.4	8	2.4	0.02	18	0.005	3.9
	0.9	0.02	14	0.4	8	2.4	0.02	19	0.005	3.7
									Avg Flow Rate	3.9

Velocity Meter Inflow Method 2	Depth (in)	Depth (m)	Width (in)	Width (m)	Channel area(m ²)	Meter value (ft/s)	Meter value (m/s)	Meter Value (m/hr)	Flow Rate (m ³ /hr)
	2.5	0.06	9	0.23	0.014	0.7	0.21	768	11.1
	2.5	0.06	9	0.23	0.014	0.6	0.18	658	9.5
	2.5	0.06	9	0.23	0.014	0.8	0.24	878	12.7
								Avg Flow Rate	11.1

Bucket Outflow Method 1	Bucket volume (gal)	Bucket volume (m ³)	Time (s)	Time (hr)	Flowrate (m ³ /hr)
	5	0.02	41	0.01	1.7
	5	0.02	41	0.01	1.7
	5	0.02	41	0.01	1.7
				Avg Flow Rate	1.7

Outflow Recorded Data	(in/Nov)	Lake Evap (in/Nov)	Lake Evap (m/Nov)	Lake Evap (m/hr)	Lake SA (m ²)	Lake Evap (m ³ /hr)
Evaporation	1.04	0.7	0.02	2.6E-05	8000	0.2

Results	(m ³ /hr)
Inflow Avg Method 1	3.9
Inflow Avg Method 2	11.1
Avg Inflow Both Methods	7.5
Avg Outflow Method 1	1.7
Recorded Lake Evap	0.2
Total Outflow (Avg Outflow + Recorded Lake Evap)	1.9

Water Balance Rate Result	Avg Inflow (m ³ /hr)	Total Outflow (m ³ /hr)	Accumulation (m ³ /hr)
Accumulation=In-Out	7.5	1.9	5.6

Accumulation is not equal to zero so the lake is not in equilibrium. Furthermore the accumulation is positive so the lake is filling up.
The lake is filling up at a rate of 6m³/hr.

Depth Change Rate	Accumulation (m ³ /hr)	Lake SA (m ²)	Depth Change (m/hr)	Depth Change (cm/hr)
	5.6	8000	0.001	0.07

For an error analysis, the depth measurement of Inflow Method 1 was decreased by 10% because this was identified as a possible source of error due to difficulty to obtaining an accurate measurement in the field.
The time measurement for the Outflow Method 1 was increased by 10%. The time measurement was identified as a possible source of error because of the difficulty in catching all the outflow of Fern Lake in a 5 gallon bucket; ie some of the outflow was not caught and not thereby measured.
This 10% change in error analysis resulted in a 90% change in the rate of accumulation. The accumulation was slower in this error analysis. Outflow was estimated to be increased where as inflow was measured to be decreased thus resulting in the adjusted accumulation rate being slower.
These results also show that a slight error in measurement compounds into a larger error in this water balance model.