Seasonal and Temporal Assessment of Surface Water Quality in Saguling Reservoir Indonesia Using Water Quality Index

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Research

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Abstract

In recent years, developments in agriculture, industry, and urban activities, especially around rivers and reservoirs have caused significant changes to the quality and quantity of water resources. This includes the Saguling Reservoir, which is located in Citarum basin, Indonesia. A review of previous studies reveals that Water Quality Index (WQI) is efficient for the identification of pollution sources as well as for the understanding of temporal and spatial variations in reservoir water quality. The National Sanitation Foundation – Water Quality Index (NSFWQI), which is a commonly used indicator of surface water quality, is based on turbidity, temperature, phosphate, nitrate, fecal coliform, pH, DO, TS, and BOD parameters. Using the results from the correlation matrix, we show that the two water quality parameters that influence the NSFWQI value the most are turbidity and fecal coliform. The average index of NSFWQI was determined to be 48.42 during the dry season, 43.97 during the normal season, and 45.82 during the wet season. A calculation of the WQI classified the water quality in the Saguling Reservoir as “bad” in condition. This study reveals that the strongest and most significant correlation between the concentration parameters and the WQI score is the turbidity concentration fecal coli, which is usable to determine the required parameters for the calculation of WQI with reduced parameters, if needed. This research also conducted nitrate concentration distribution analysis around Saguling Reservoir using the Inverse Distance Weighted method.

Full Text

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Tables

Table 1. Water quality monitoring locations in the Saguling Reservoir

MONITORING STATION	LOCATION	GPS (decimal unit)	
		LS	BT
1a	Citarum River	107°32'10,7"	06°56'29,8"
1b	Citarum River Trash Boom Batujajar	107°28'35,0"	06°54'58,9"
2	Cihaur Cipeundeuy Village	107°28'32,3"	06°53'13,5"
3	Cimerang	107°27'09,0"	06°53'13,4"
4	Muara Cihaur Kampung Maroko	107°25'54,4"	06°54'13,0"
5	Muara Cipatik	107°27'25,5"	06°56'07,6"
6	Muara Ciminyak – floating nets fishing location	107°26'03,8"	06°57'14,6"
7	Muara Cijere	107°24'50,8"	06°56'14,9"
8	Muara Cijambu	107°22'22,4"	06°56'00,4"
9	Near Intake Structure	107°22'26,3"	06°54'54,4"
10a	Tailrace	107°20'57,0"	06°51'49,8"

Table 2. NSFWQI

No	Score	Description
1	91-100	Excellent water quality
2	71-90	Good water quality
3	51-70	Medium or average water quality
4	26-50	Fair water quality
5	0-25	Poor water quality

Table 3. Weighting factor of water quality parameter for NSFWQI method

No	Parameter	Code	Unit	Weighting factor
1	Temperature	T	°C	0.1
2	Dissolved solid	TDS	mg/L	0.07
3	Turbidity	TUR	NTU	0.08
4	Ph	pH		0.11
5	Nitrates	NO3-N	mg/L	0.1
6	Total Phosphate (TP)	PO4	mg/L	0.1
7	Dissolved oxygen	DO	mg/L	0.17
8	Biochemical Oxygen Demand	BOD	mg/L	0.11
9	Fecal Coli	FC	Colony/100mL	0.16

Table 4. Water Quality Data of Saguling Reservoir at Normal Year

No	Parameter	Temperature			Total Dissolved Solids			Turbidity			pH			Nitrate			Phosphate			Dissolved Oxygen			B C
	Location	°C			mg/L			NTU			-			mg/L			mg/L			mg/L			n
1	Nanjung	26,3	±	1,0	241,8	±	108,4	196,3	±	135,8	7,5	±	0,4	2,6	±	1,5	0,5	±	0,2	0,8	±	1,4	4
2	Batujajar	26,8	±	0,5	228,7	±	93,3	87,7	±	71,0	7,4	±	0,3	1,8	±	0,9	0,3	±	0,1	1,0	±	1,3	1
3	Cihaur	27,4	±	0,4	308,2	±	104,4	71,6	±	59,4	7,9	±	0,4	1,9	±	0,8	0,3	±	0,1	1,0	±	1,4	1
4	Cimerang	27,3	±	0,2	252,8	±	66,7	43,6	±	40,7	8,1	±	1,9	2,5	±	2,0	1,3	±	2,2	1,1	±	1,5	1
5	Muara Cihaur	27,3	±	0,2	203,8	±	55,8	33,6	±	38,0	7,6	±	0,3	1,2	±	0,4	0,4	±	0,2	1,2	±	1,5	1
6	Muara Cipatik	27,2	±	0,2	123,1	±	32,4	41,9	±	38,5	7,6	±	0,3	1,2	±	0,2	0,4	±	0,1	1,1	±	1,6	1
7	Muara Ciminyak	27,9	±	1,3	111,1	±	25,5	35,8	±	31,2	7,5	±	0,2	1,4	±	0,4	0,3	±	0,1	1,1	±	1,4	1
8	Muara Cijere	27,2	±	0,3	143,7	±	37,5	34,3	±	34,4	7,7	±	0,2	1,6	±	0,6	0,3	±	0,2	1,3	±	1,9	1
9	Muara Cijambu	27,7	±	1,1	155,1	±	42,8	57,2	±	60,2	10,7	±	6,7	1,2	±	0,6	0,3	±	0,1	1,1	±	1,5	1
10	Intake	27,0	±	0,6	161,4	±	41,3	37,4	±	42,5	7,8	±	0,3	1,4	±	0,6	0,3	±	0,1	1,4	±	1,9	1
11	Tailrace	26,7	±	0,1	181,8	±	0,0	32,9	±	0,0	12,0	±	0,0	1,7	±	0,0	0,2	±	0,0	1,0	±	0,0	1

Table 5. Water Quality Data of Saguling Reservoir at Dry Year

No	Parameter	Temperature			Total Dissolved Solids			Turbidity			pH			Nitrate			Phospate			Dissolved Oxygen			BOD
	Location	°C			mg/L			mg/L			-			mg/L			mg/L			mg/L			mg/L
1	Nanjung	25,9	±	0,7	320,4	±	117,0	220,9	±	187,9	7,4	±	0,1	3,3	±	1,1	0,4	±	0,2	0,6	±	1,0	5
2	Batuajar	27,5	±	0,6	296,9	±	52,0	50,2	±	49,2	7,6	±	0,1	2,6	±	0,6	0,3	±	0,1	0,9	±	1,2	2
3	Cihaur	27,7	±	0,5	330,5	±	52,7	62,5	±	45,4	8,2	±	0,3	2,4	±	1,0	0,3	±	0,1	0,8	±	1,1	2
4	Cimerang	25,0	±	5,8	266,7	±	31,6	45,6	±	55,8	8,0	±	0,3	2,1	±	0,7	0,2	±	0,1	0,9	±	1,3	1
5	Muara Cihaur	27,4	±	0,5	250,3	±	34,8	44,0	±	50,4	7,7	±	0,1	2,0	±	0,5	0,3	±	0,1	1,0	±	1,4	1
6	Muara Cipatik	26,1	±	3,0	139,5	±	15,9	41,9	±	53,1	7,7	±	0,4	1,6	±	0,4	0,3	±	0,1	1,0	±	1,4	1
7	Muara Ciminyak	27,3	±	0,4	136,9	±	19,9	40,7	±	52,0	7,5	±	0,1	1,6	±	0,4	0,3	±	0,1	0,9	±	1,3	9
8	Muara Cijere	26,2	±	3,0	162,1	±	27,0	27,8	±	25,8	7,6	±	0,3	1,7	±	0,4	0,3	±	0,1	1,1	±	1,5	9
9	Muara Cijambu	27,3	±	0,3	162,2	±	5,3	39,5	±	53,9	7,6	±	0,2	1,4	±	0,4	0,2	±	0,1	1,0	±	1,4	8
10	Intake	26,9	±	0,2	182,5	±	26,0	39,6	±	39,5	11,6	±	9,1	1,6	±	0,4	0,3	±	0,1	1,2	±	1,7	1
11	Tailrace	26,8	±	0,2	209,6	±	0,0	27,6	±	0,0	7,2	±	0,0	1,6	±	0,0	0,2	±	0,0	1,0	±	0,0	9

Table 6. Water Quality Data of Saguling Reservoir at Wet Year

No	Parameter	Temperatur			Total Dissolved Solids			Turbidity			pH			Nitrate			Phospate			Dissolved Oxygen			BOD
	Location	°C			mg/L			NTU			-			mg/L			mg/L			mg/L			mg/L
1	Nanjung	25,8	±	0,4	245,5	±	83,4	193,6	±	101,6	7,4	±	0,2	2,5	±	1,5	0,3	±	0,1	1,5	±	1,4	2
2	Batuajar	26,9	±	0,7	213,8	±	49,6	62,9	±	50,4	7,4	±	0,2	1,7	±	0,8	0,3	±	0,1	2,9	±	3,4	1
3	Cihaur	26,1	±	3,3	299,1	±	77,1	56,0	±	53,0	7,4	±	1,4	2,1	±	1,3	0,3	±	0,2	2,2	±	2,7	2
4	Cimerang	25,8	±	3,2	240,7	±	58,8	40,1	±	35,3	7,4	±	0,9	1,7	±	1,0	0,2	±	0,1	2,5	±	3,2	1
5	Muara Cihaur	25,8	±	3,3	200,4	±	52,4	38,7	±	31,0	7,1	±	0,8	2,0	±	0,8	0,2	±	0,1	1,7	±	1,5	1
6	Muara Cipatik	25,9	±	3,2	123,5	±	22,0	45,3	±	35,2	7,0	±	0,9	1,3	±	0,7	0,3	±	0,1	1,8	±	1,7	9
7	Muara Ciminyak	25,9	±	3,2	114,8	±	23,2	40,0	±	35,2	6,9	±	0,8	1,2	±	0,6	0,3	±	0,1	1,7	±	1,6	7
8	Muara Cijere	25,9	±	3,3	146,1	±	26,5	39,6	±	34,8	7,0	±	0,9	1,5	±	1,0	0,2	±	0,1	1,7	±	1,5	1
9	Muara Cijambu	25,9	±	3,5	154,6	±	33,9	43,9	±	40,8	7,1	±	0,8	1,4	±	0,9	0,2	±	0,1	1,6	±	1,5	9
10	Intake	25,6	±	3,4	165,1	±	39,4	39,4	±	38,8	6,8	±	0,9	1,5	±	1,0	0,2	±	0,1	1,9	±	1,8	1
11	Tailrace	25,2	±	3,2	181,5	±	0,0	49,3	±	0,0	6,8	±	0,0	1,4	±	0,0	0,2	±	0,0	1,0	±	0,0	1

Figures

Figure 1

Water quality monitoring locations in the Saguling Reservoir

Figure 2

(a). NSF-WQI during the Dry Season. (b). NSF-WQI value during value the Dry Season for each monitoring location

Figure 3

(a). NSF-WQI value in the Normal Season. (b). NSF-WQI value during the Normal Season for each monitoring location

Figure 4

(a). NSF-WQI value during the Wet Season. (b). NSF-WQI value during the Wet Season for each monitoring location

Figure 5

Nitrate distribussion during Wet Year

Figure 6

Nitrate distribution at Normal Year

Figure 7

Nitrate distribussion at Dry Year