

SUPPLEMENTARY MATERIAL

A data-driven approach to predict hydrometeorological variability and fluctuations in lake water levels

Remziye I. Tan Kesgin¹⁾ , Ibrahim Demir²⁾ , Erdal Kesgin³⁾ ,
Mohamed Abdelkader⁴⁾  , Hayrullah Agaccioglu²⁾ 

¹⁾ Fatih Sultan Mehmet Vakıf University, Faculty of Engineering, Department of Civil Engineering, Beyoglu, 34445, Istanbul, Turkey

²⁾ Yıldız Technical University, Faculty of Civil Engineering, Department of Civil Engineering, Esenler, 34210, Istanbul, Turkey

³⁾ Istanbul Technical University, Faculty of Civil Engineering, Department of Civil Engineering, Maslak, 34469, Istanbul, Turkey

⁴⁾ Stevens Institute of Technology, Department of Civil, Environmental, and Ocean Engineering, 1 Castle Point Terrace, Hoboken, NJ 07030, USA

Table S1. Akaike's information criterion (AICc) values for various autoregressive moving average (ARMA) (p, q) models applied evaporation, precipitation, and water level data in Beyşehir Lake

Variable	ARMA	MA (0)	MA (1)	MA (2)	MA (3)	MA (4)
Lake level	AR (0)	677.6334	316.5497	222.4014	-132.4292	-253.9433
	AR (1)	-200.2986	-347.9307	-407.47684	-420.9517	-444.7351
	AR (2)	-422.4884	-425.9504	-431.36937	-434.3104	-444.8570
	AR (3)	-429.5778	-465.5641	-428.00258	-538.0659	-442.8887
Precipitation	AR (0)	977.2883	969.9693	971.8249	972.0701	971.0463
	AR (1)	970.0716	971.8871	972.8015	961.4456	962.9014
	AR (2)	971.7404	959.0873	972.2262	938.3644	936.7424
	AR (3)	972.1333	957.8852	961.4303	939.7533	942.1780
Evaporation	AR (0)	1542.392	1298.1739	1163.4931	1094.9270	1087.3250
	AR (1)	1209.347	1146.1138	1091.2854	1080.9344	1074.2360
	AR (2)	1067.555	1005.7834	997.4424	933.7558	1057.7890
	AR (3)	1005.477	998.0646	1000.3250	–	–

Explanations: values in bold = best fit.

Source: own study.

Table S2. Akaike's information criterion (AICc) values for various autoregressive integrated moving average (ARIMA) (p, d, q) models applied evaporation, precipitation, and water level data in Beyşehir Lake

Variable	ARIMA	MA (0)	MA (1)	MA (2)	MA (3)	MA (4)
Lake level	AR (0)	-201.8619	-347.5660	-404.1352	-415.3403	-434.0953
	AR (1)	-404.5521	-412.0807	-419.0658	-421.3716	-432.1808
	AR (2)	-419.5230	-468.1749	-503.6891	-540.8112	-544.6373
	AR (3)	-445.0156	-479.3604	-547.6275	-545.3446	-
Precipitation	AR (0)	1120.423	980.7033	973.0922	974.8958	975.4328
	AR (1)	1073.009	973.1297	974.9765	967.8942	966.4469
	AR (2)	1055.403	974.8620	976.5958	977.8202	971.5998
	AR (3)	1043.495	975.3987	977.5689	971.8558	973.5960
Evaporation	AR (0)	1227.934	1177.3125	1136.8568	1136.6934	1092.8100
	AR (1)	1154.535	1156.3314	1137.0409	1138.0461	1080.1840
	AR (2)	1156.034	1153.4452	909.0805	889.5909	867.1585
	AR (3)	1122.412	992.7496	899.5352	868.4076	893.3034

Explanations: values in bold = best fit.

Source: own study.

Table S3. Akaike's information criterion (AICc) values for various seasonal autoregressive integrated moving average (SARIMA) $(p, d, q) (P, D, Q)_s$ models applied evaporation, precipitation, and water level data in Beyşehir Lake

Variable	Model	AICc
Lake level	SARIMA (0, 1, 0) (0, 1, 0) ₁₂	-320.67
	SARIMA (0, 1, 1) (0, 1, 0) ₁₂	-378.84
	SARIMA (0, 1, 0) (1, 1, 0) ₁₂	-380.04
	SARIMA (1, 1, 3) (0, 1, 0) ₁₂	-388.89
	SARIMA (0, 1, 3) (0, 1, 0) ₁₂	-389.41
	SARIMA(1, 1, 2) (0, 1, 0) ₁₂	-389.96
	SARIMA (0, 1, 2) (0, 1, 0) ₁₂	-391.40
	SARIMA (0, 1, 2) (0, 1, 0) ₁₂	-391.95
	SARIMA (2, 1, 0) (0, 1, 0) ₁₂	-391.95
	SARIMA (3, 0, 1) (0, 1, 1) ₁₂	-520.51
Precipitation	SARIMA (0, 1, 1) (0, 1, 2) ₁₂	944.75
	SARIMA (0, 1, 1) (1, 1, 1) ₁₂	944.77
	SARIMA (0, 1, 1) (0, 1, 1) ₁₂	945.01
	SARIMA (0, 1, 2) (0, 1, 2) ₁₂	945.71
	SARIMA (0, 1, 2) (0, 1, 2) ₁₂	945.72
	SARIMA (1, 1, 1) (1, 1, 1) ₁₂	945.87
	SARIMA (1, 1, 1) (0, 1, 2) ₁₂	945.87
	SARIMA (0, 1, 2) (0, 1, 1) ₁₂	946.14
	SARIMA (1, 1, 1) (0, 1, 1) ₁₂	946.25
	SARIMA (2, 0, 2) (2, 0, 0) ₁₂	938.52
Evaporation	SARIMA (2, 1, 1) (1, 1, 1) ₁₂	674.59
	SARIMA (2, 1, 1) (0, 1, 2) ₁₂	675.24
	SARIMA (2, 1, 1) (2, 1, 1) ₁₂	676.14
	SARIMA (2, 1, 1) (1, 1, 2) ₁₂	676.17
	SARIMA (1, 1, 3) (1, 1, 1) ₁₂	676.32
	SARIMA (2, 1, 1) (0, 1, 3) ₁₂	676.35
	SARIMA (1, 1, 2) (1, 1, 1) ₁₂	676.57
	SARIMA (2, 1, 1) (0, 1, 1) ₁₂	676.75
	SARIMA (1, 1, 3) (0, 1, 2) ₁₂	676.96
	SARIMA (2, 0, 0) (0, 1, 2) ₁₂	671.37

Explanations: values in bold = best fit.

Source: own study.

Table S4. Calculated model performance criteria for best-fit models

Parameter	Model		Best-fit model	<i>R</i>	<i>MAE</i>	<i>RMSE</i>	<i>MASE</i>
Lake level	forecasting	ARMA	ARMA (0, 3)	0.860	0.148	0.189	1.095
			training	0.858	0.148	0.190	1.116
			testing	0.834	0.096	0.121	0.597
		ARIMA	ARIMA (0, 1, 0)	0.904	0.139	0.183	1.025
			training	0.914	0.137	0.183	1.028
			testing	0.932	0.193	0.277	1.199
		SARIMA	SARIMA (0, 1, 0) (0, 1, 0) ₁₂	0.826	0.113	0.270	0.836
			training	0.815	0.113	0.280	0.852
			testing	0.836	0.282	0.752	1.745
	auto	SARIMA (3, 0, 1) (0, 1, 1) ₁₂		0.963	0.110	0.243	0.816
Precipitation	forecasting	ARMA	ARMA (2, 4)	0.920	0.836	1.138	0.7274
			training	0.916	0.830	1.132	0.736
			testing	0.936	0.836	1.107	0.621
		ARIMA	ARIMA (1, 1, 4)	0.957	0.905	1.197	0.787
			training	0.955	0.891	1.189	0.790
			testing	0.945	0.890	1.247	0.663
		SARIMA	SARIMA (0, 1, 1) (0, 1, 2) ₁₂	0.822	0.869	1.187	0.756
			training	0.816	0.840	1.162	0.745
			testing	0.674	0.460	0.858	0.343
	auto	SARIMA (2, 0, 2) (2, 0, 0) ₁₂		0.972	0.832	1.140	0.783
Evaporation	forecasting	ARMA	ARMA (2, 3)	0.888	0.917	1.122	0.677
			training	0.805	0.859	1.072	0.649
			testing	0.842	0.740	0.949	0.475
		ARIMA	ARIMA (2, 1, 4)	0.851	0.805	1.006	0.595
			training	0.880	0.817	1.011	0.617
			testing	0.880	0.938	1.194	0.602
		SARIMA	SARIMA (2, 1, 1) (1, 1, 1) ₁₂	0.881	0.495	0.745	0.366
			training	0.886	0.474	0.724	0.358
			testing	0.879	0.321	0.718	0.206
	auto	SARIMA (2, 0, 0) (0, 1, 2) ₁₂		0.931	0.507	0.744	0.872

Explanations: ARMA = autoregressive moving average, ARIMA = autoregressive integrated moving average, SARIMA = seasonal autoregressive integrated moving average, *R* = correlation coefficient, *MAE* = mean absolute error, *RMSE* = root mean squared error, *MASE* = mean absolute scaled error.

Source: own study.