

Electronic Supplementary Material

Modeling the Changes in Water Balance Components of Highly Irrigated Western Part of Bangladesh

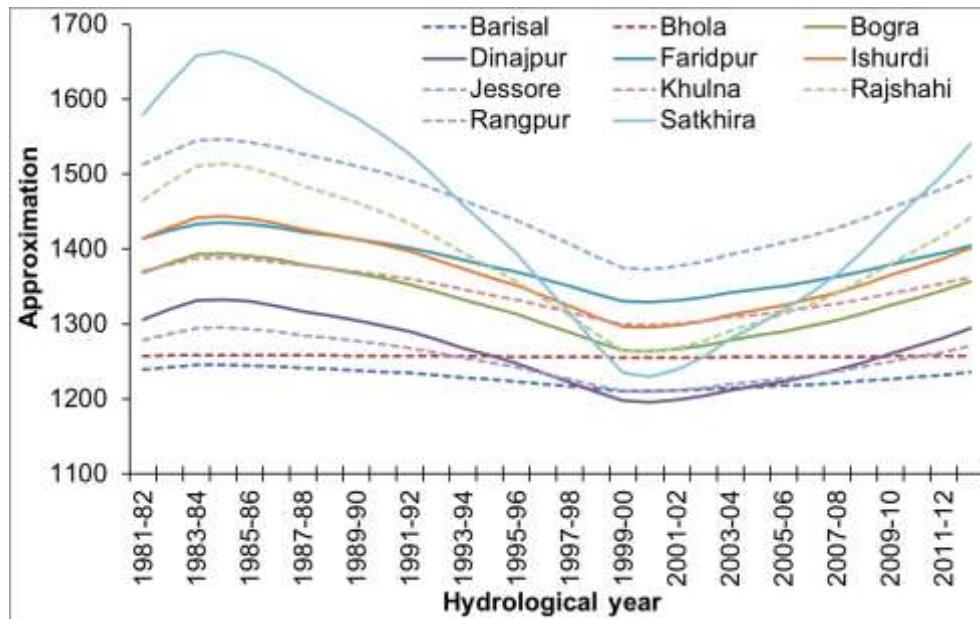


Figure S1. Approximation time series of P_{ET} obtained from DWT for the hydrological period of 1981-82 to 2012-13

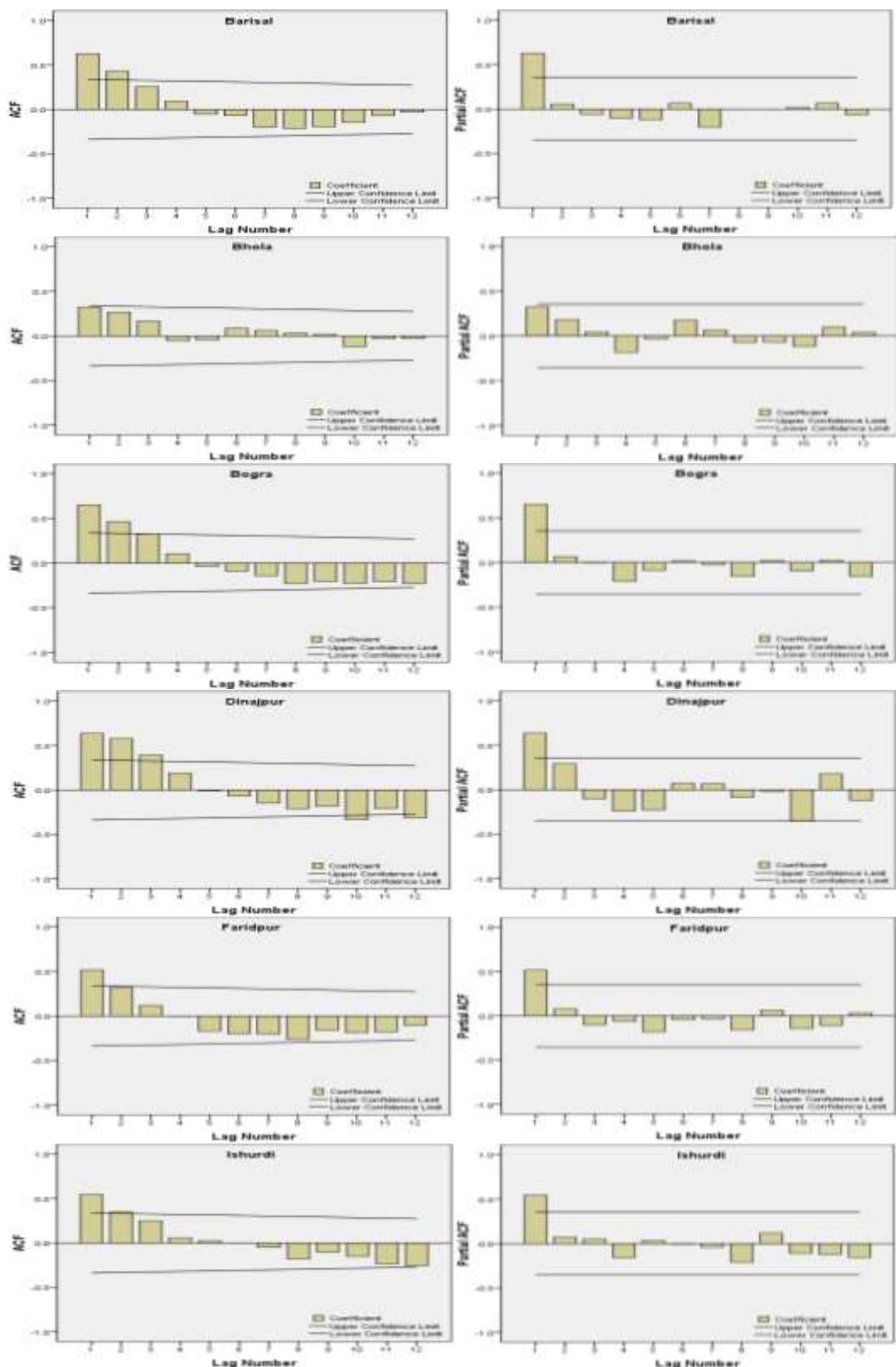


Figure S2. (a) Plot of auto-correlation function (ACF) and partial auto-correlation function (PACF) of actual P_{ET} data time series data that are used to identify order (p, d, q) of ARIMA model. The solid lines represent the 95% confidence intervals.

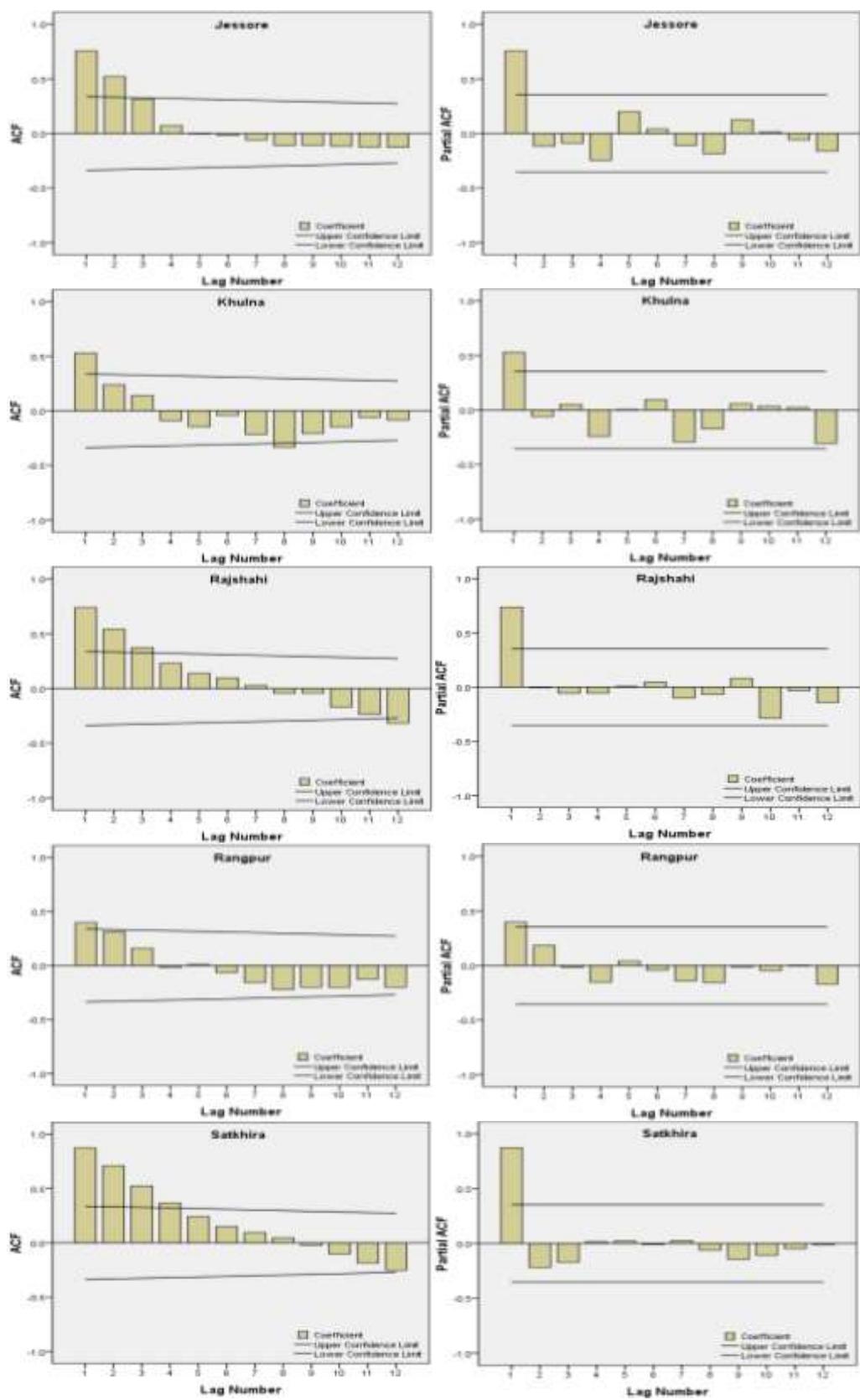


Figure S2. (a) (Continued)

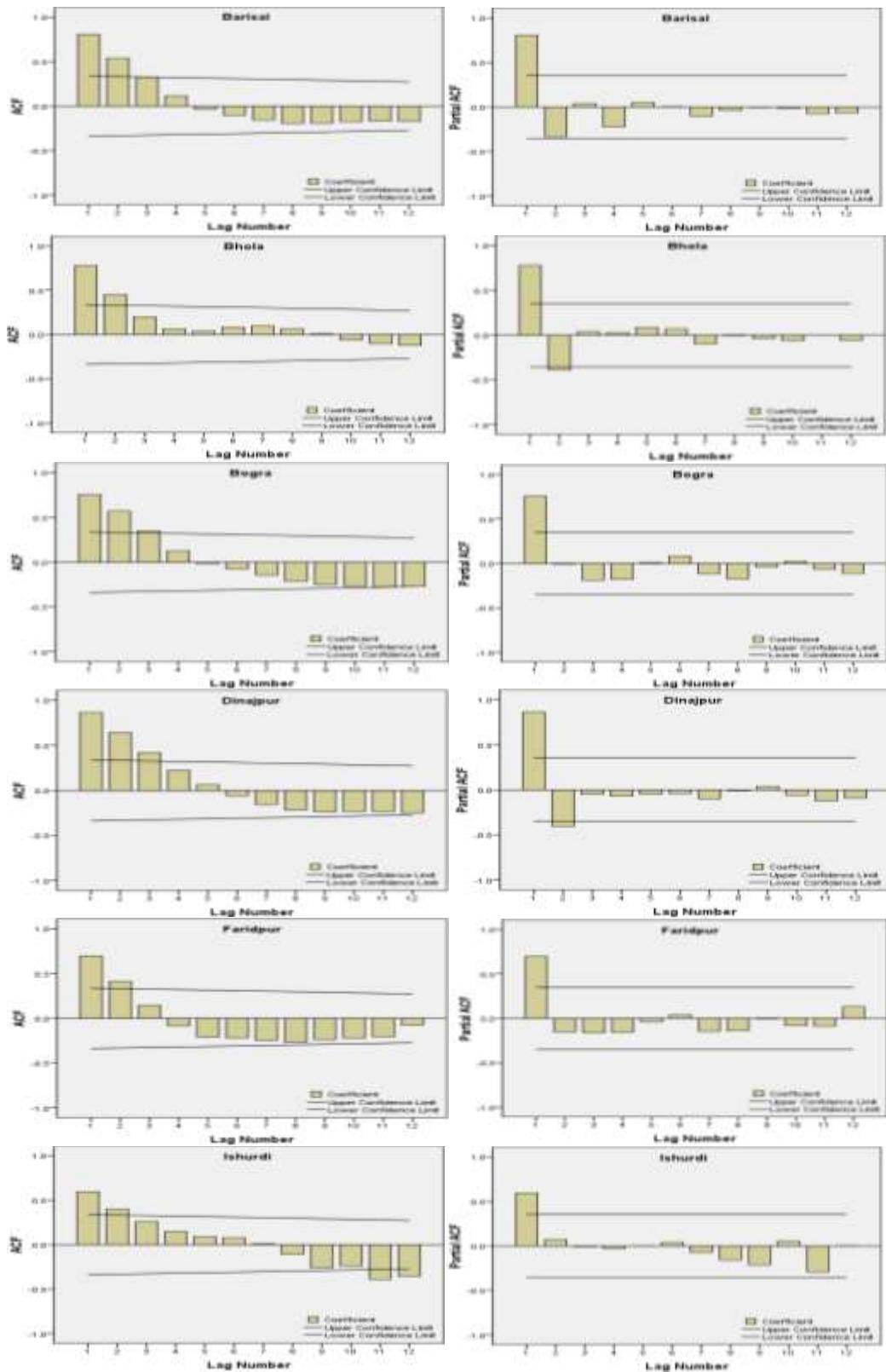


Figure S2. (b) Plot of auto-correlation function (ACF) and partial auto-correlation function (PACF) of DWT denoised P_{ET} time series data that are used to identify order (p, d, q) of ARIMA model. The solid lines represent the 95% confidence intervals. It is notable that lag-1 auto-correlation is higher than actual (See Fig. S2.a) data that also satisfy the condition of denoising.

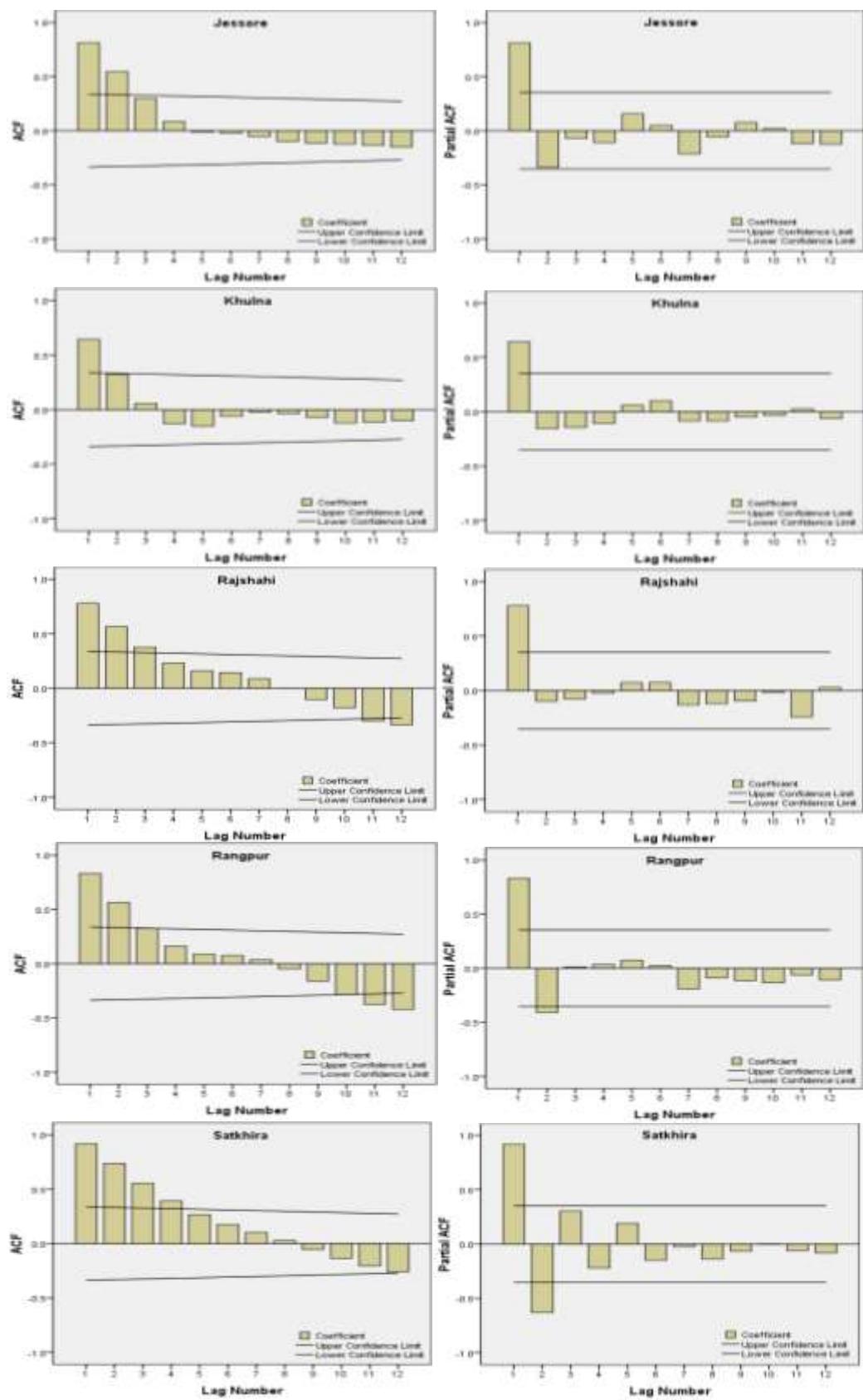


Figure S2. (b) (Continued)

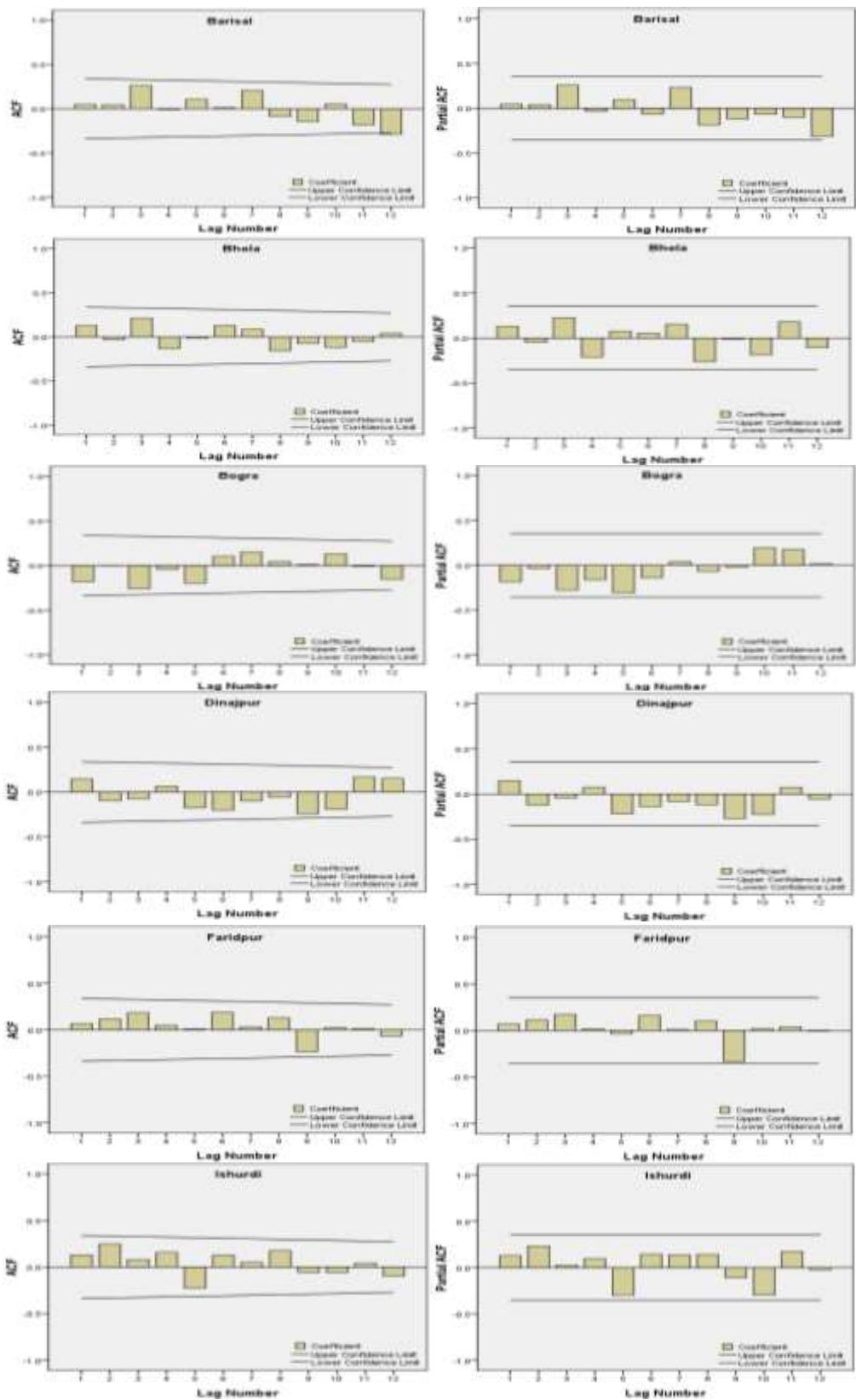


Figure S3. (a) Plot of auto-correlation function (ACF) and partial auto-correlation function (PACF) of actual A_{ET} data. It is observed that there is no spike that cross the solid lines (represent the 95% confidence intervals). Therefore, classical ARIMA model is not suitable for modeling the A_{ET} .

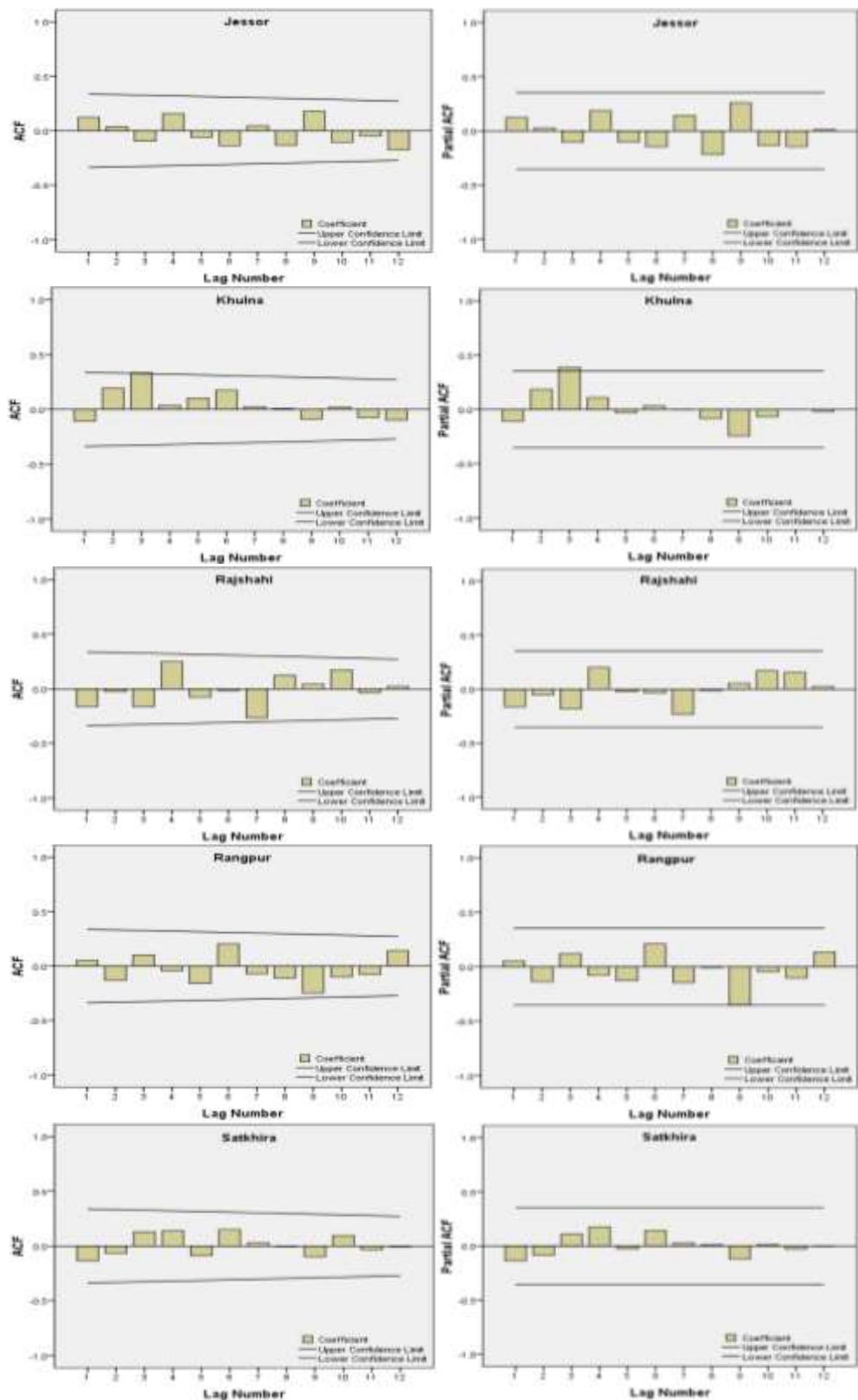


Figure S3. (a) (Continued) it is observed that there is no spike that cross the solid lines (represent the 95% confidence intervals) except Khulna station. Therefore, classical ARIMA model is not suitable for modeling the A_{ET} .

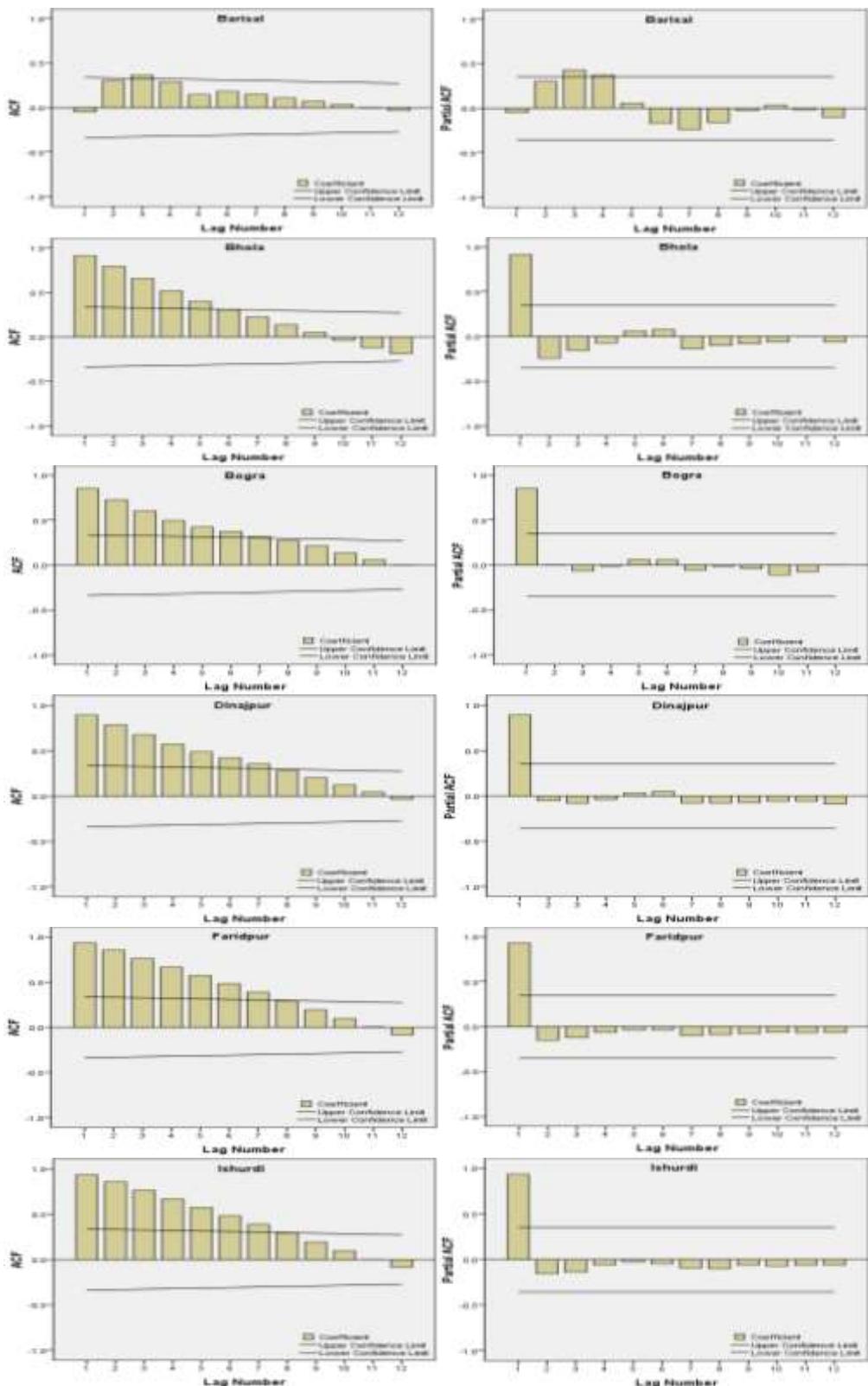


Figure S3. (b) Plot of auto-correlation function (ACF) and partial auto-correlation function (PACF) of DWT denoised A_{ET} time series data. It is observed that there are spike at different lags that cross the solid lines (represent the 95% confidence intervals). Therefore, ARIMA model is suitable for modeling the denoised A_{ET} time series data. It is also seen that lag-1 auto-correlation is higher than the figures in Fig. S3 (a) that also satisfy the condition of denoising.

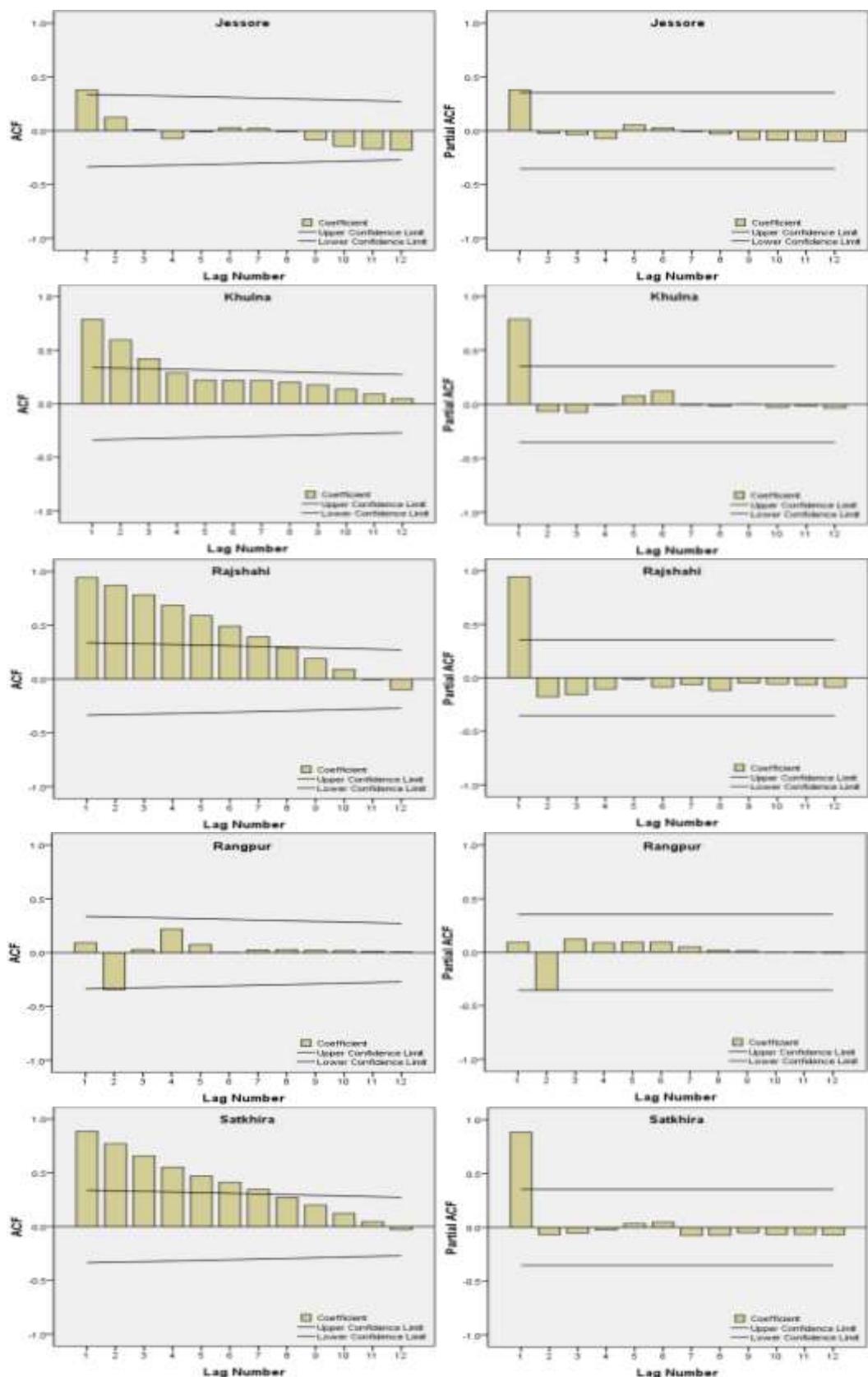


Figure S3. (b) Continued

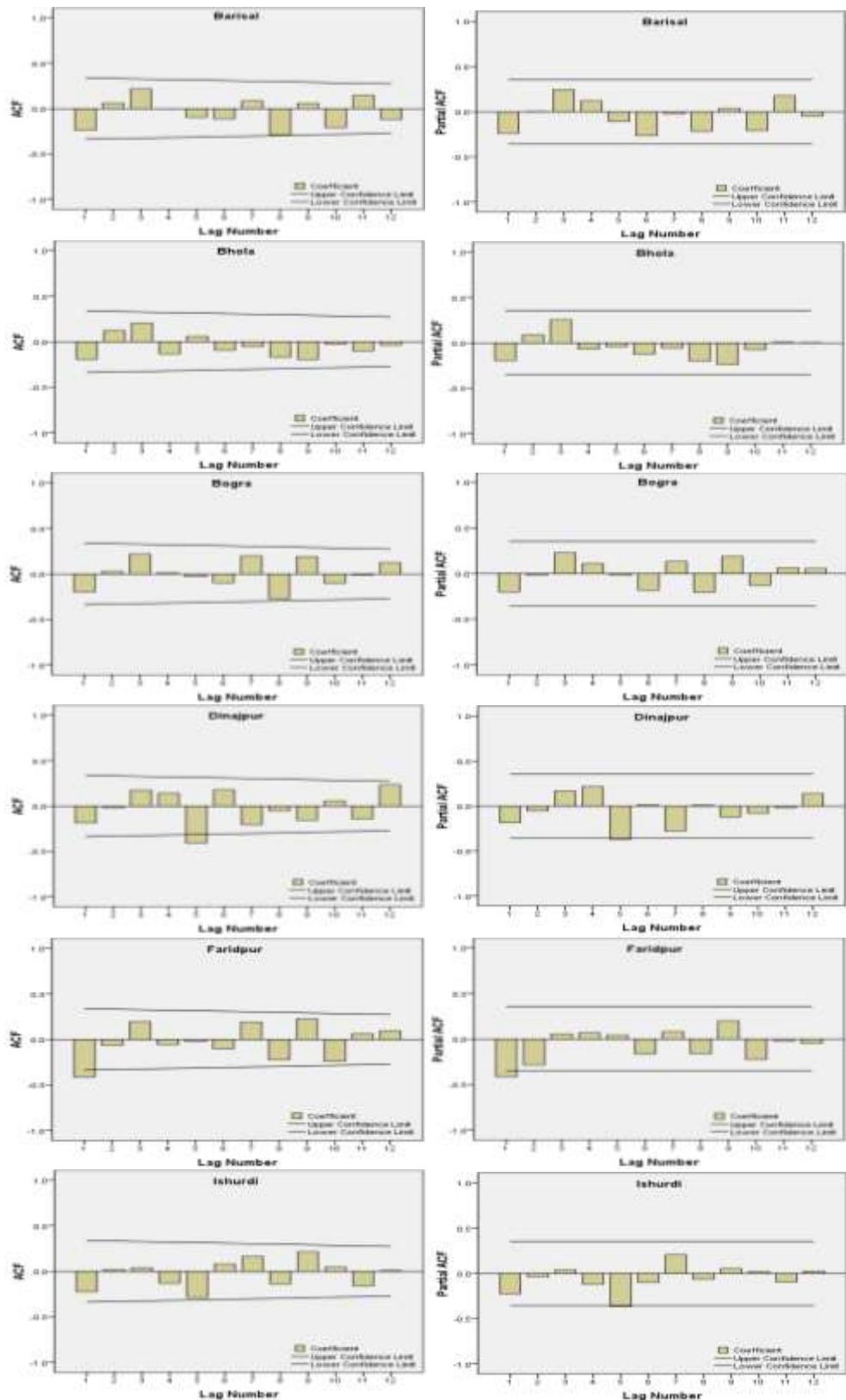


Figure S4. (a) Plot of auto-correlation function (ACF) and partial auto-correlation function (PACF) of actual annual surplus data. It is observed that there is no spike that cross the solid lines (represent the 95% confidence intervals) except a few cases. Therefore, classical ARIMA model is not suitable for modeling the annual surplus.

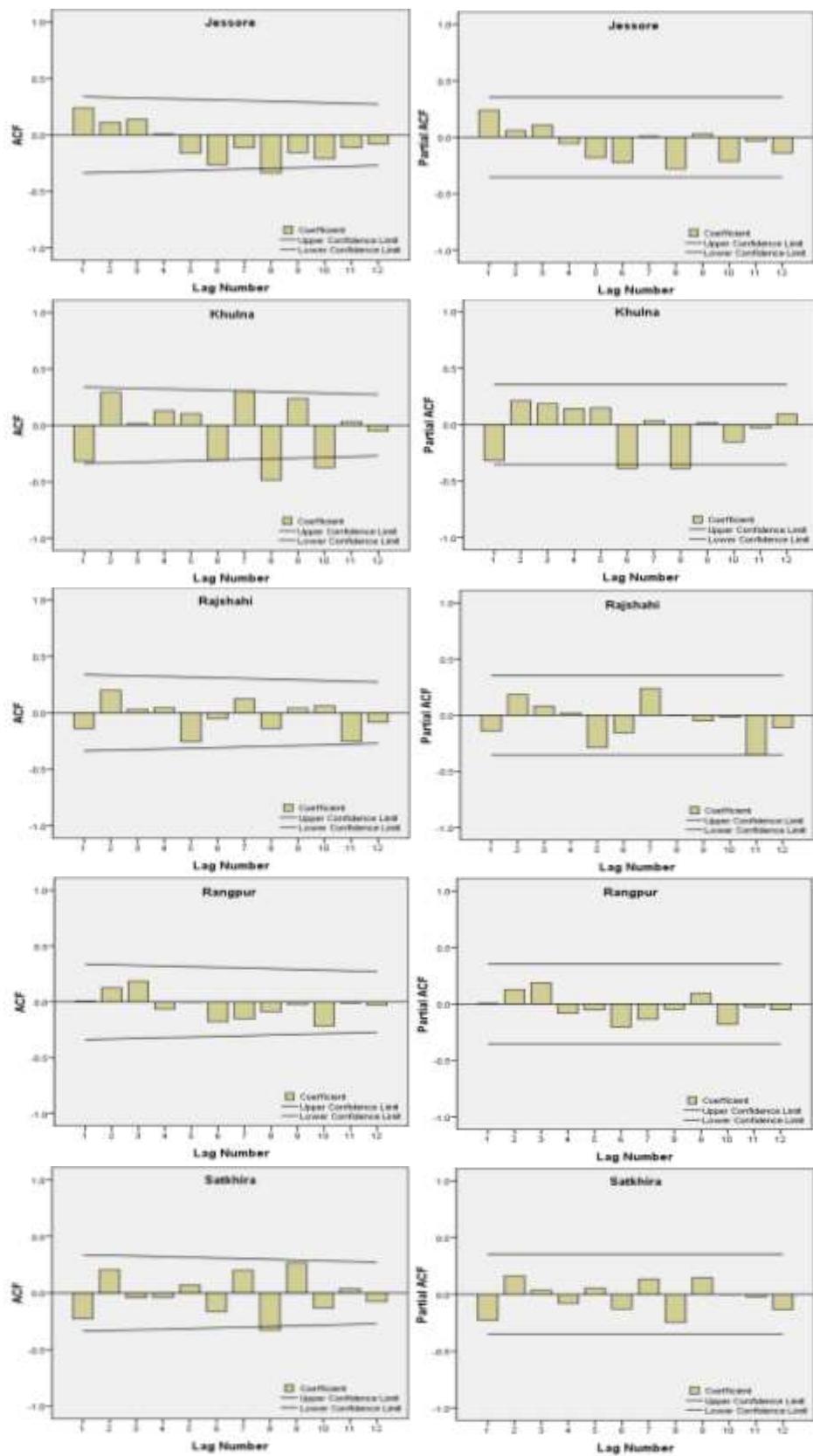


Figure S4. (a) (Continued)

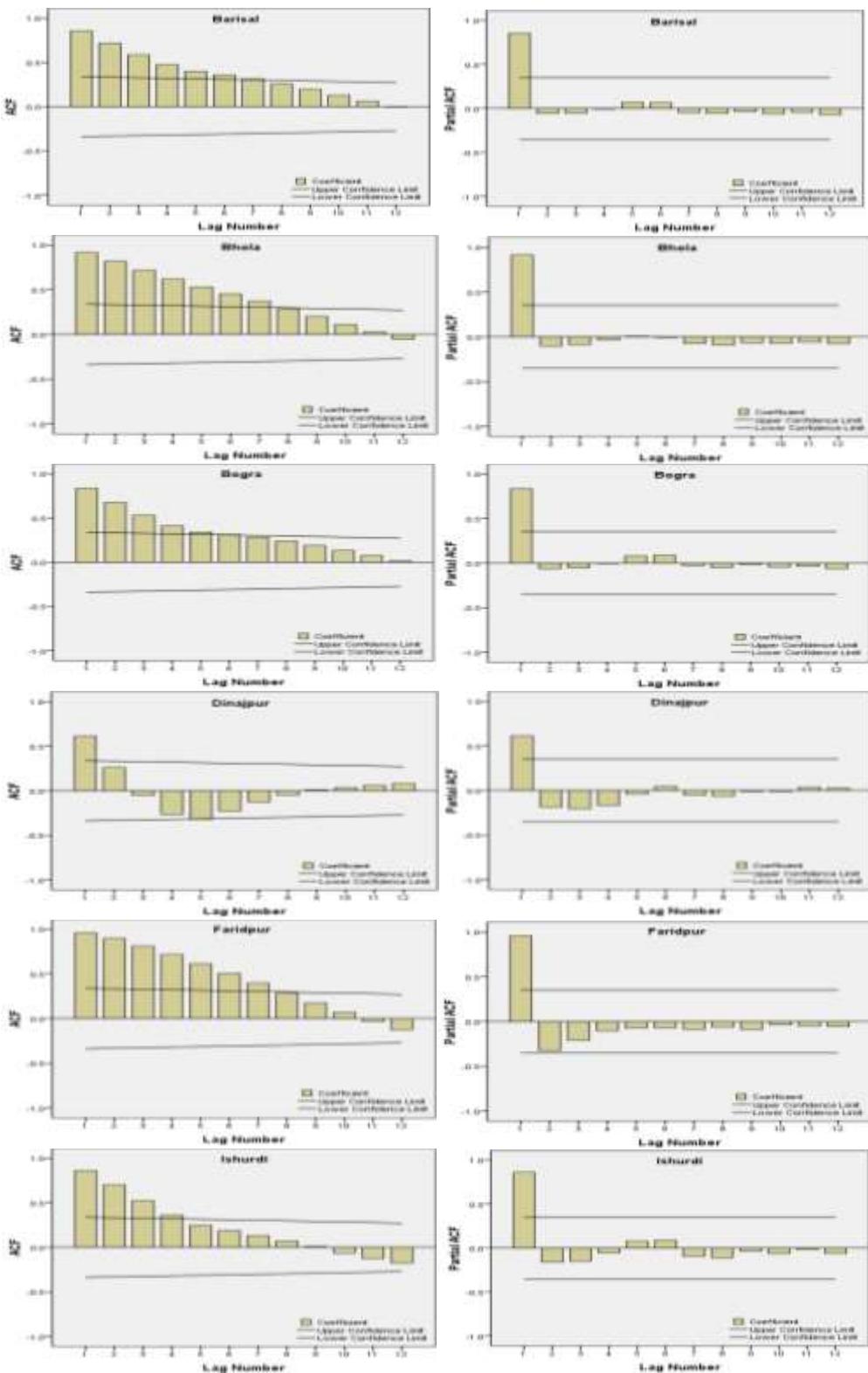


Figure S4. (b) Plot of auto-correlation function (ACF) and partial auto-correlation function (PACF) of DWT denoised annual surplus time series data. It is observed that there are spike at different lags that cross the solid lines (represent the 95% confidence intervals). Therefore, ARIMA model is suitable for modeling the denoised annual surplus time series data. It is also seen that lag-1 auto-correlation is higher than the figure in S3 (a) that also satisfy the condition of denoising.

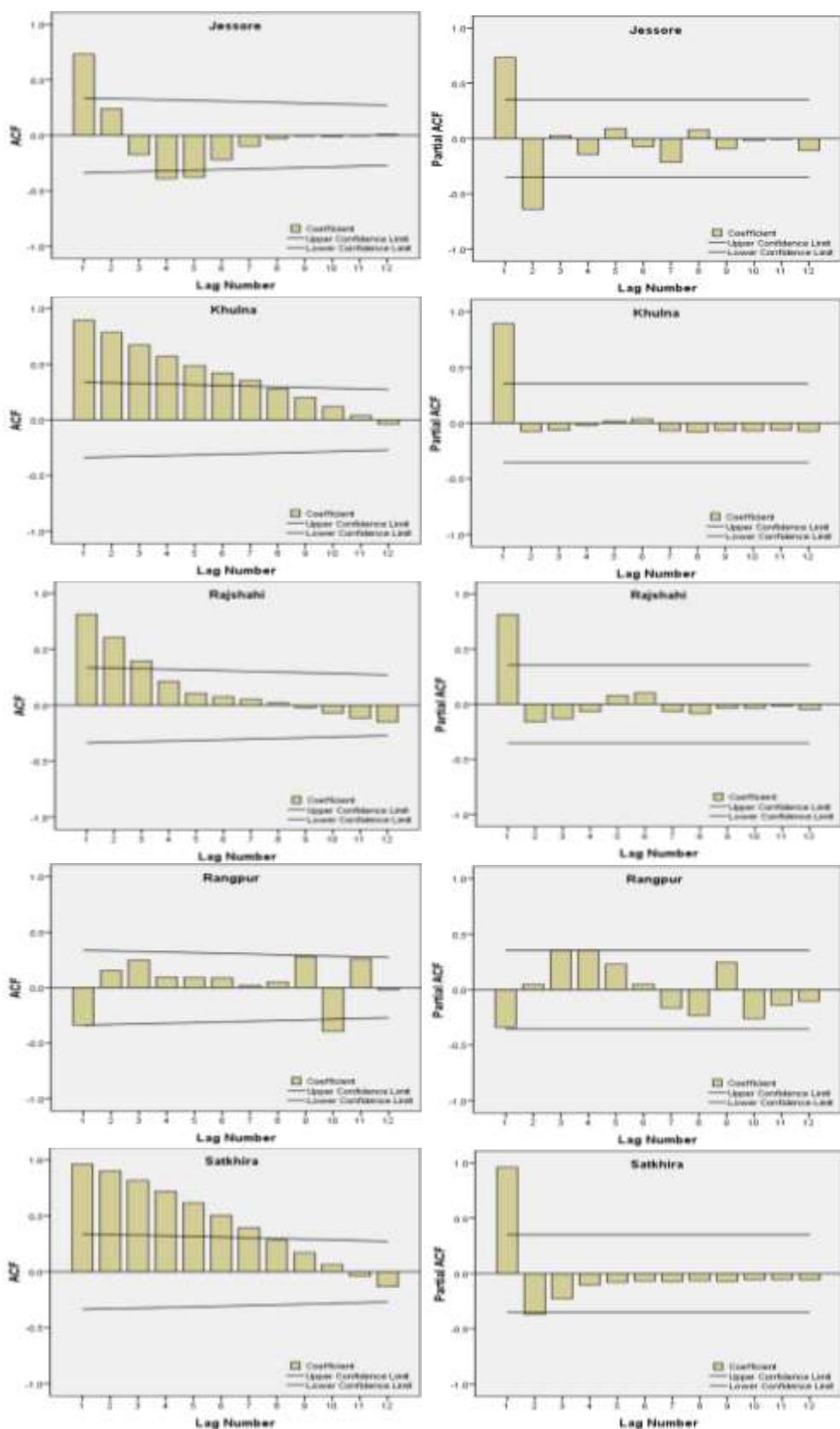


Figure S4. (b) (Continued)

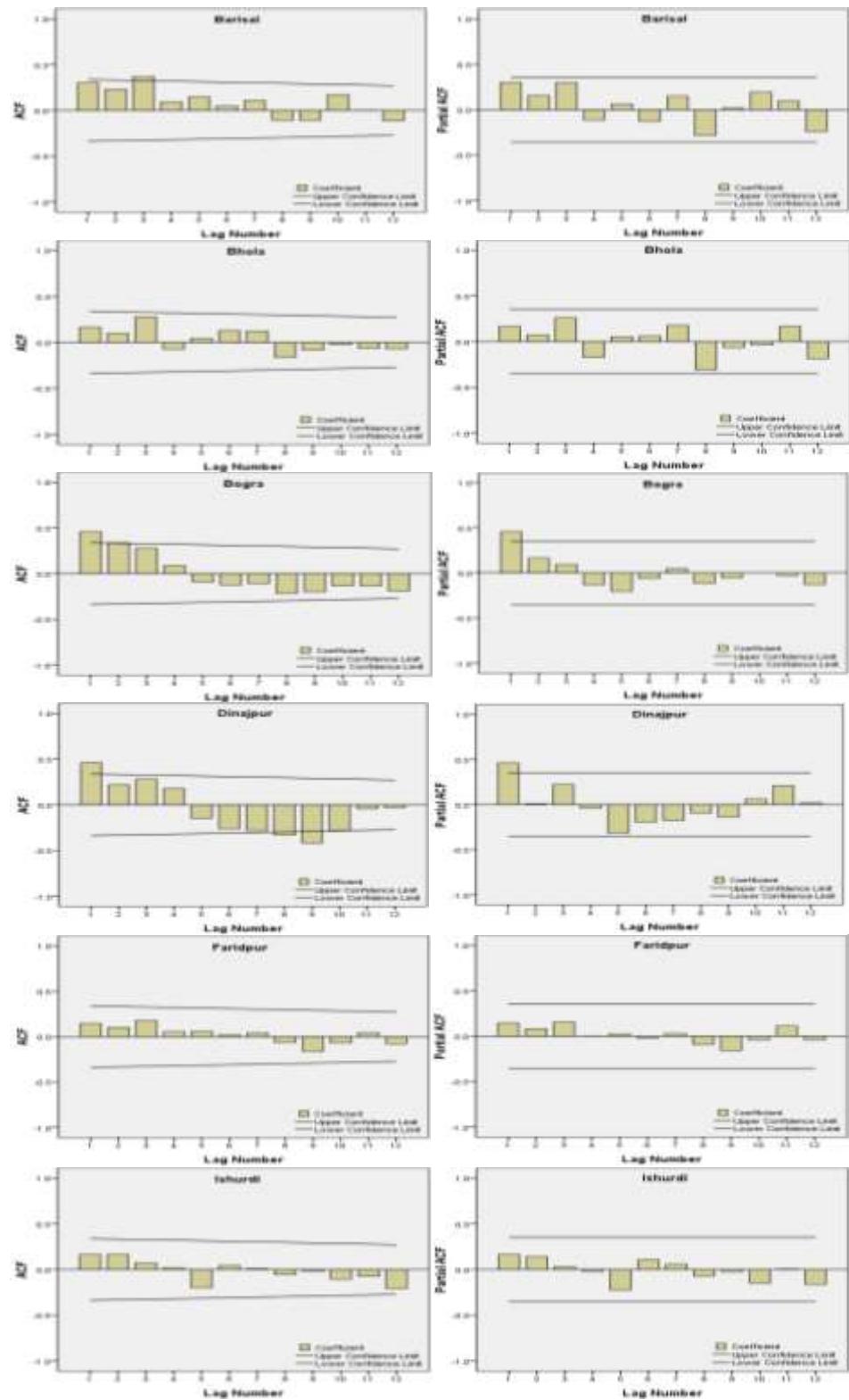


Figure S5. (a) Plot of auto-correlation function (ACF) and partial auto-correlation function (PACF) of actual deficit time series data. It is observed that there is no spike that cross the solid lines (represent the 95% confidence intervals) except some cases. Therefore, classical ARIMA model is not suitable for modeling the annual deficit.

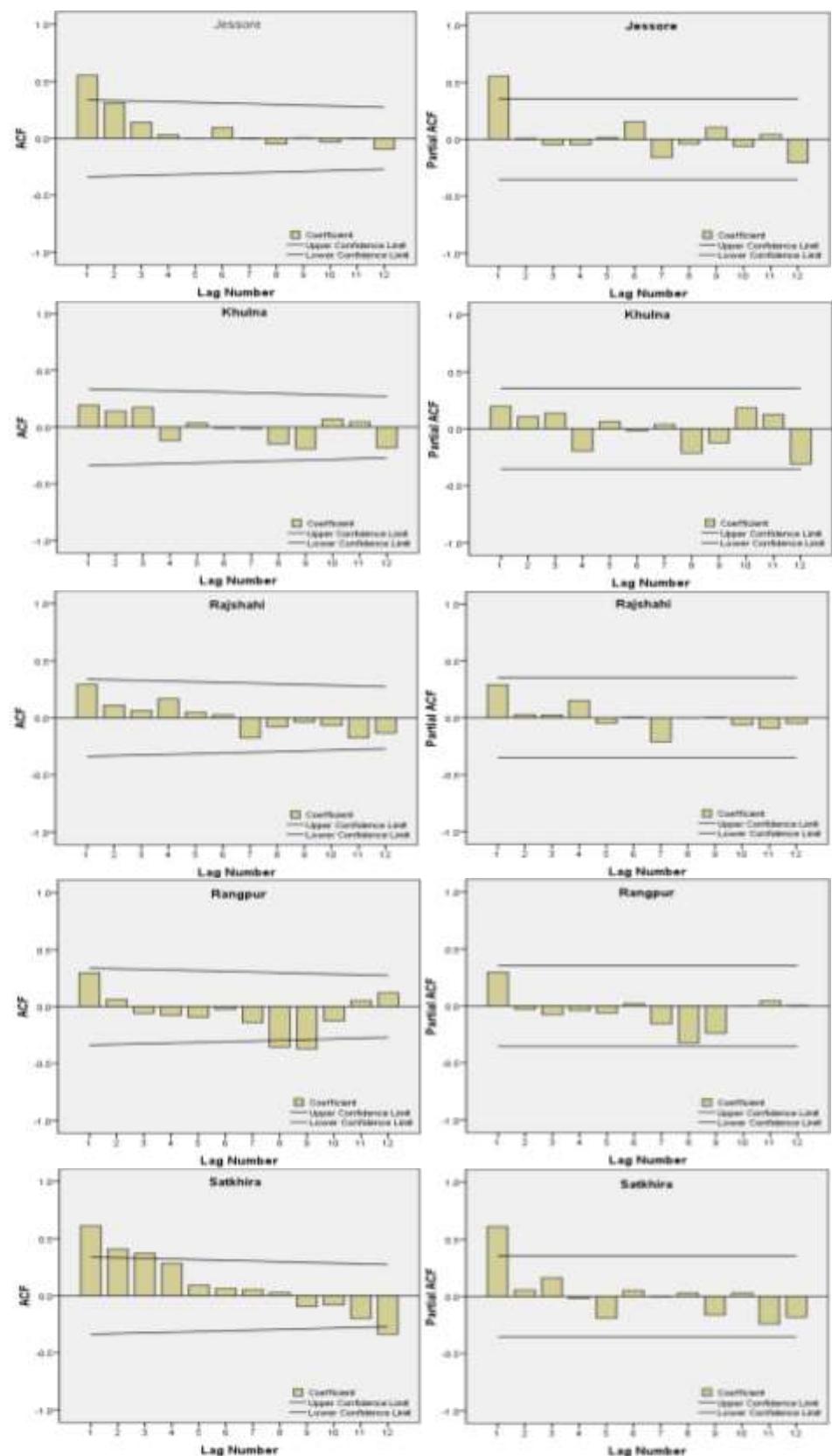


Figure S5. (a) (Continued)

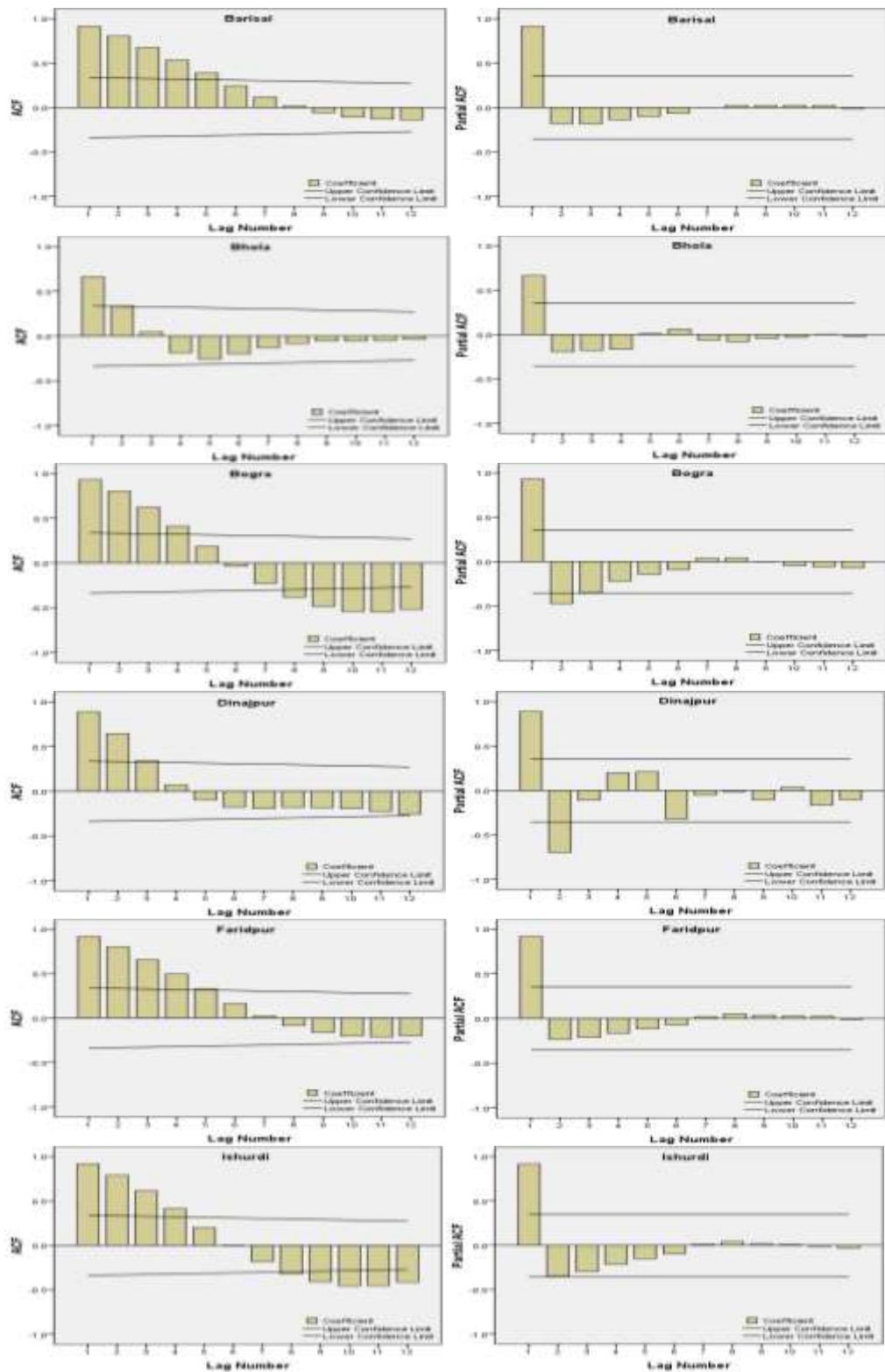


Figure S5. (b) Plot of auto-correlation function (ACF) and partial auto-correlation function (PACF) of DWT denoised annual deficit time series data. It is observed that there are spike at different lags that cross the solid lines (represent the 95% confidence intervals). Therefore, ARIMA model is suitable for modeling the denoised annual deficit time series data. It is also seen that lag-1 auto-correlation is higher than the figure in S3 (a) that also satisfy the condition of denoising.

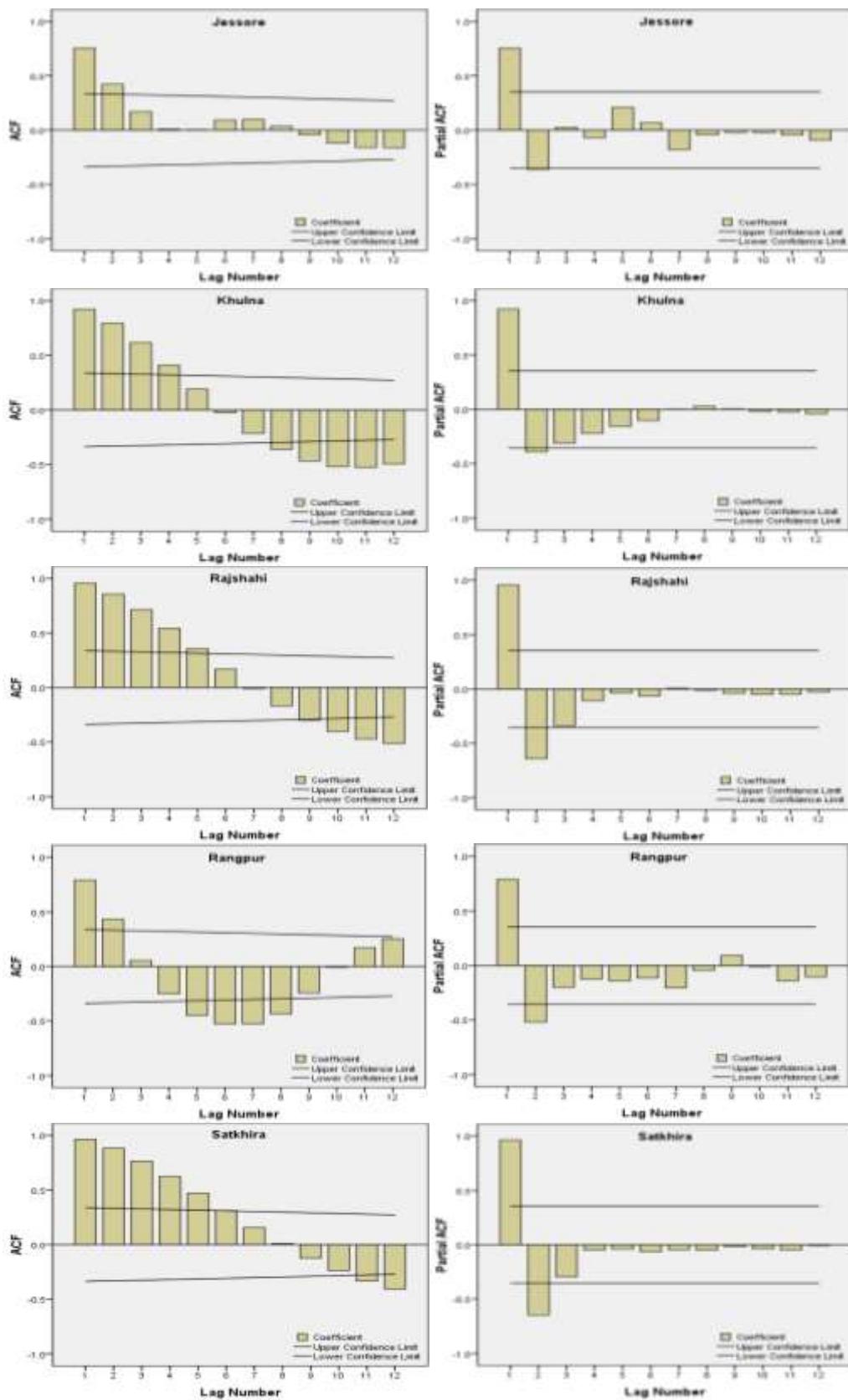


Figure S5. (b) (Continued)

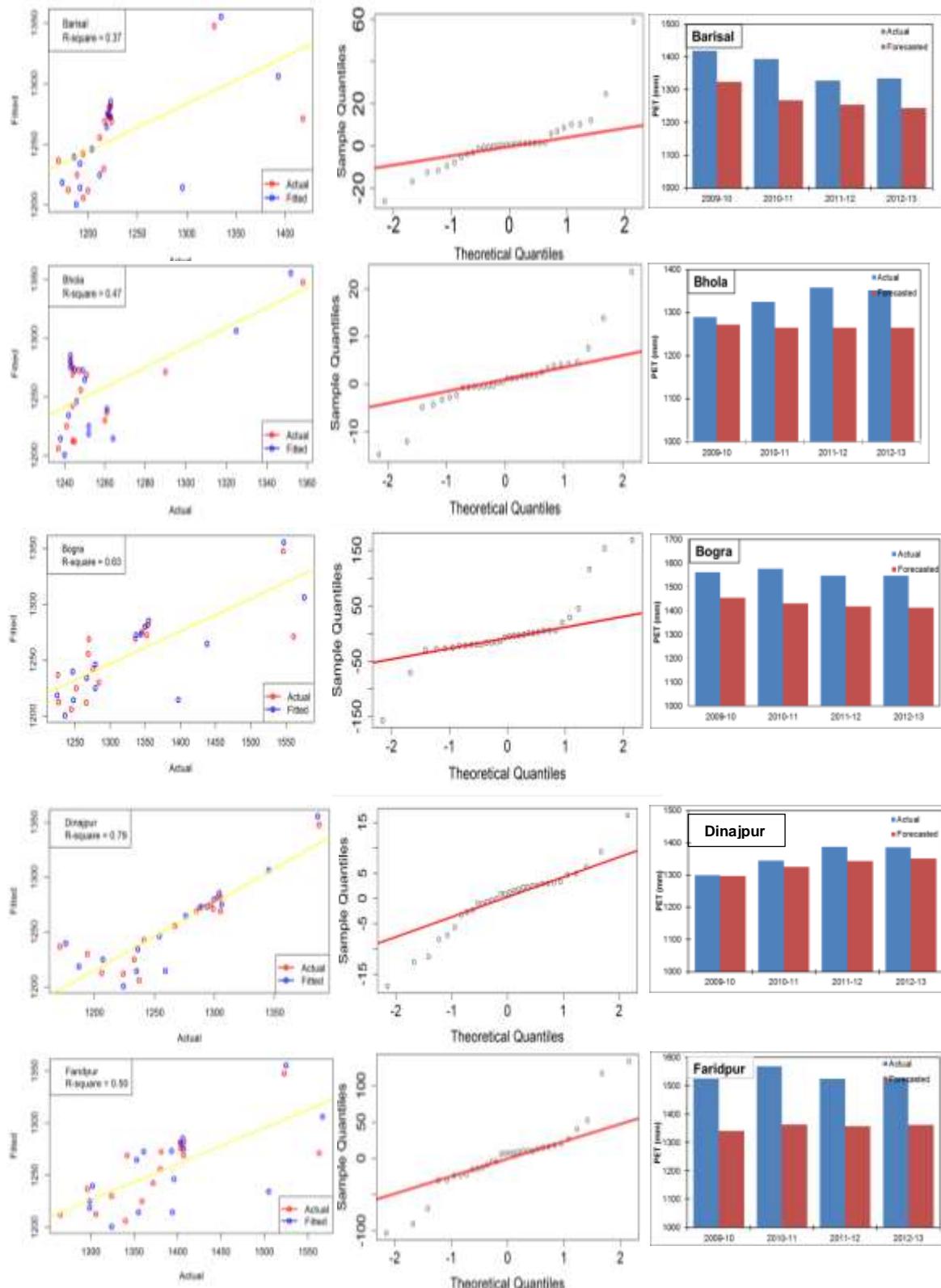


Figure S6. Plot of best wavelet ARIMA model of PET first panel represents actual versus fitted values for the period of 1981-82 to 2012-2013, second panel is normal Q-Q plot of residuals of the model, and third panel shows actual, fitted and forecasted values for the period of 2009-2010 to 2012-13

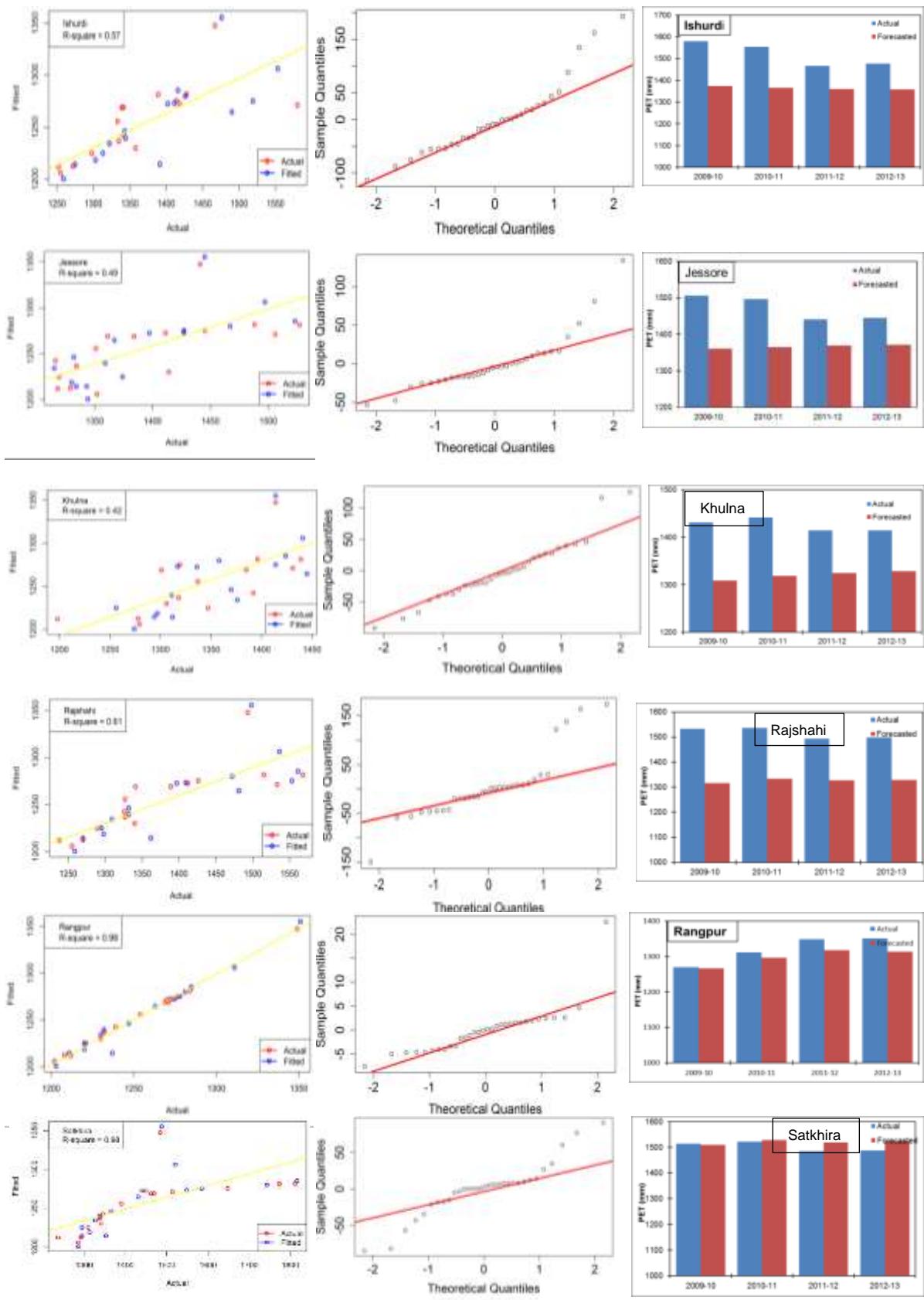


Figure S6. (Continued)

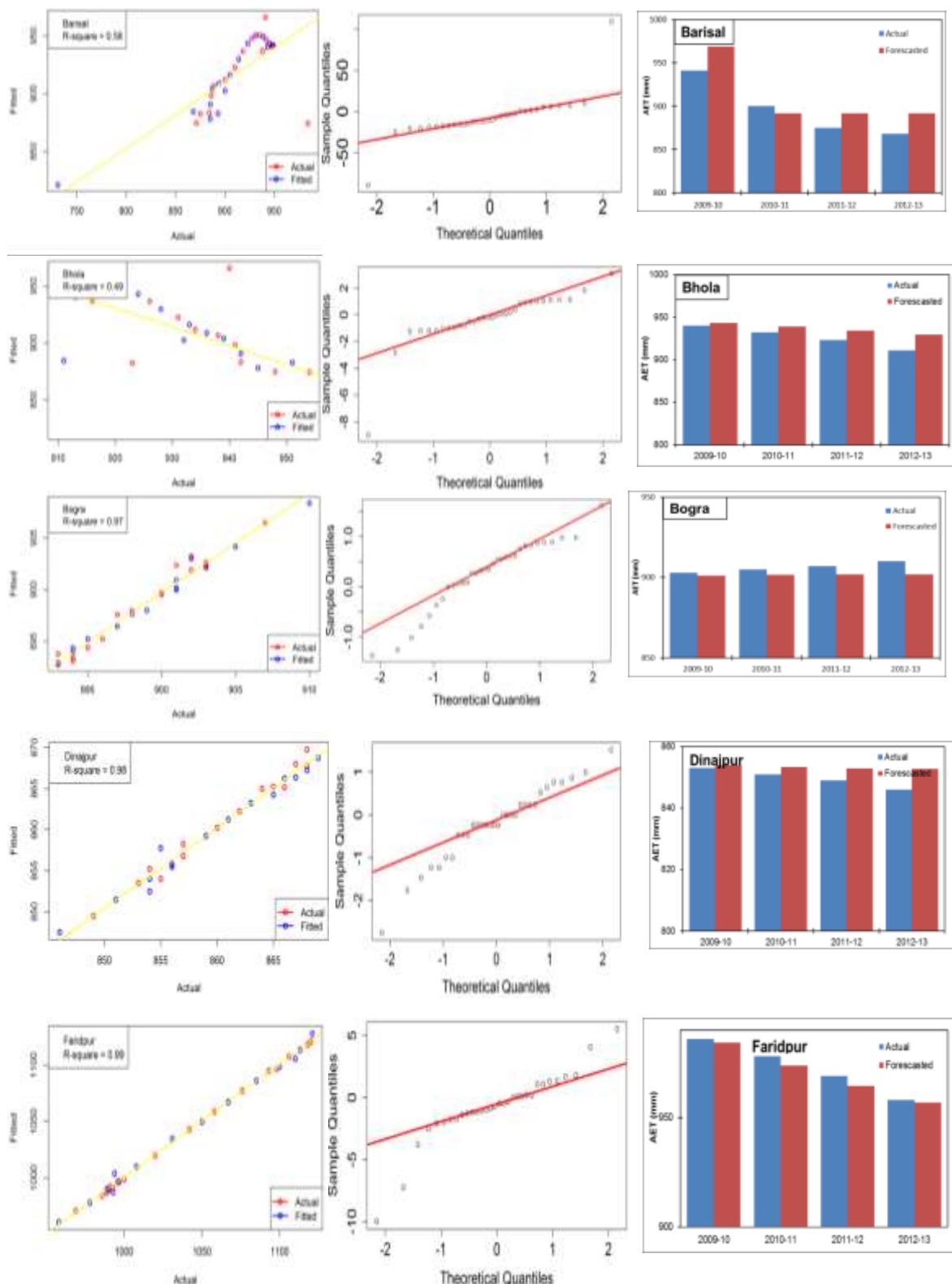


Figure S7. Plot of best wavelet ARIMA model of AET first panel represents actual versus fitted values for the period of 1981-82 to 2012-2013, second panel is normal Q-Q plot of residual of the model, and third panel shows actual, fitted and forecasted values for the period of 2009-2010 to 2012-13.

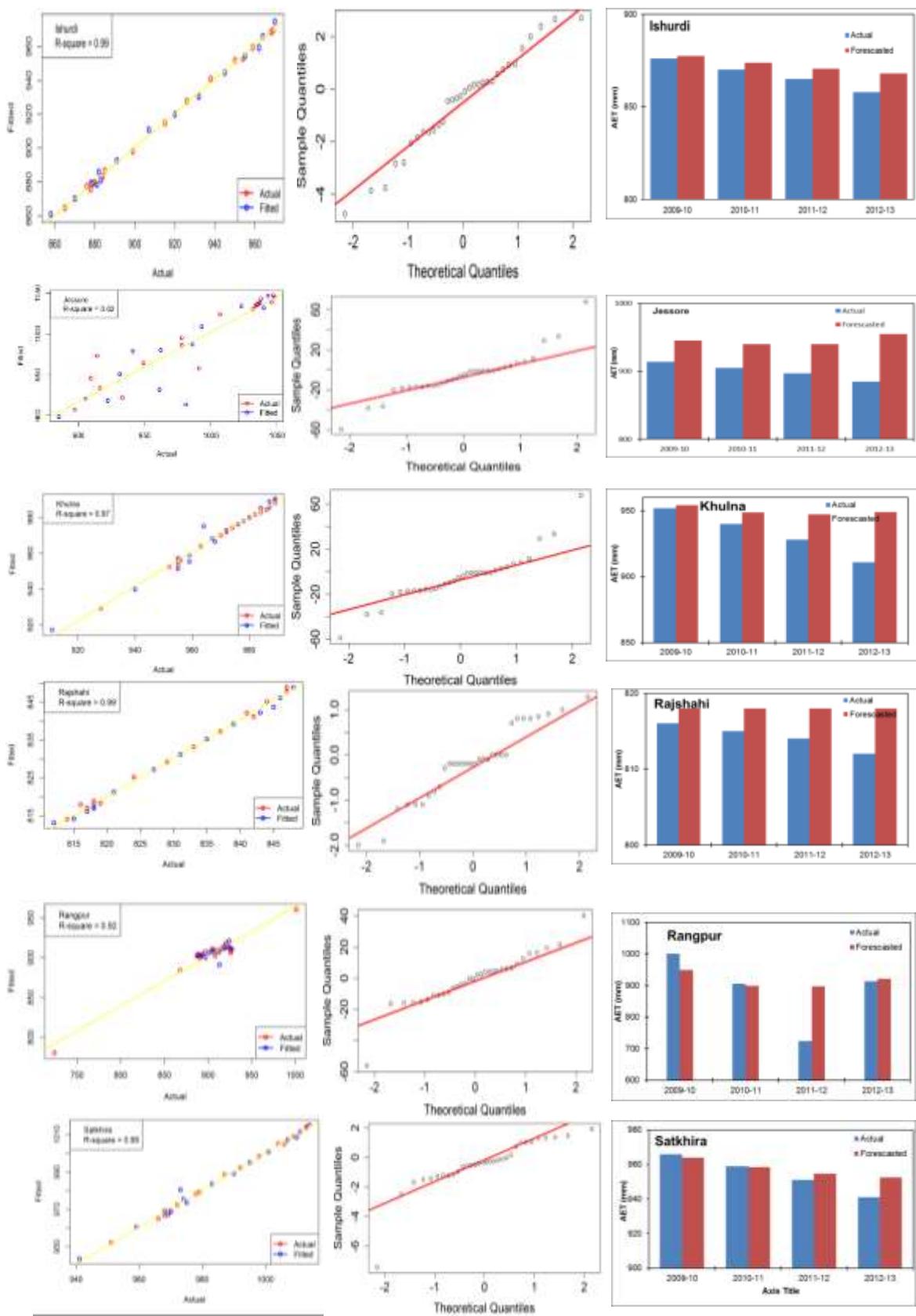


Figure S7. (Continued)

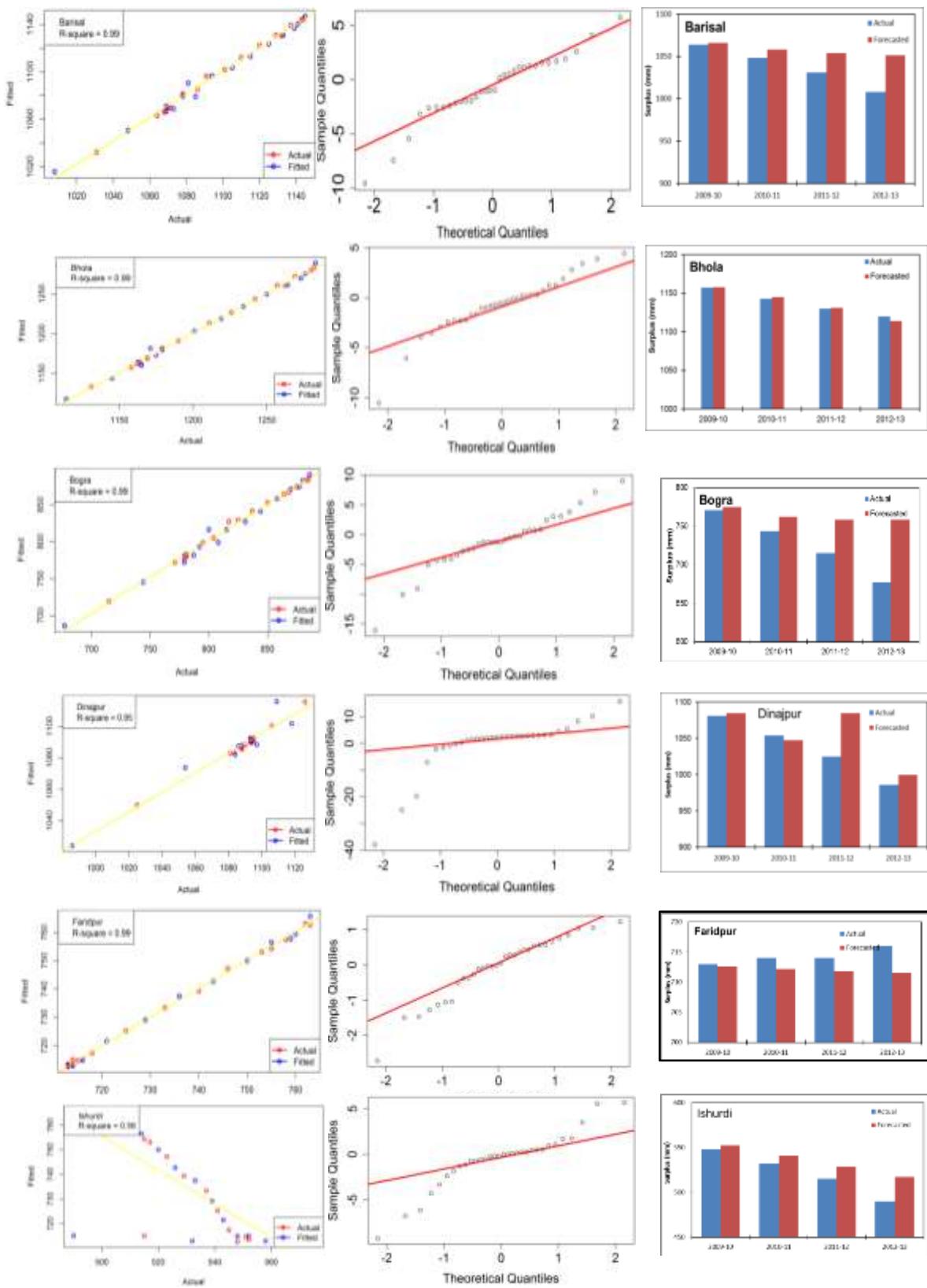


Figure S8. Plot of best wavelet ARIMA model of annual surplus first panel represents actual versus fitted values for the period of 1981-82 to 2012-2013, second panel is normal Q-Q plot of residual of the model, and third panel shows actual, fitted and forecasted values for the period of 2009-2010 to 2012-13.

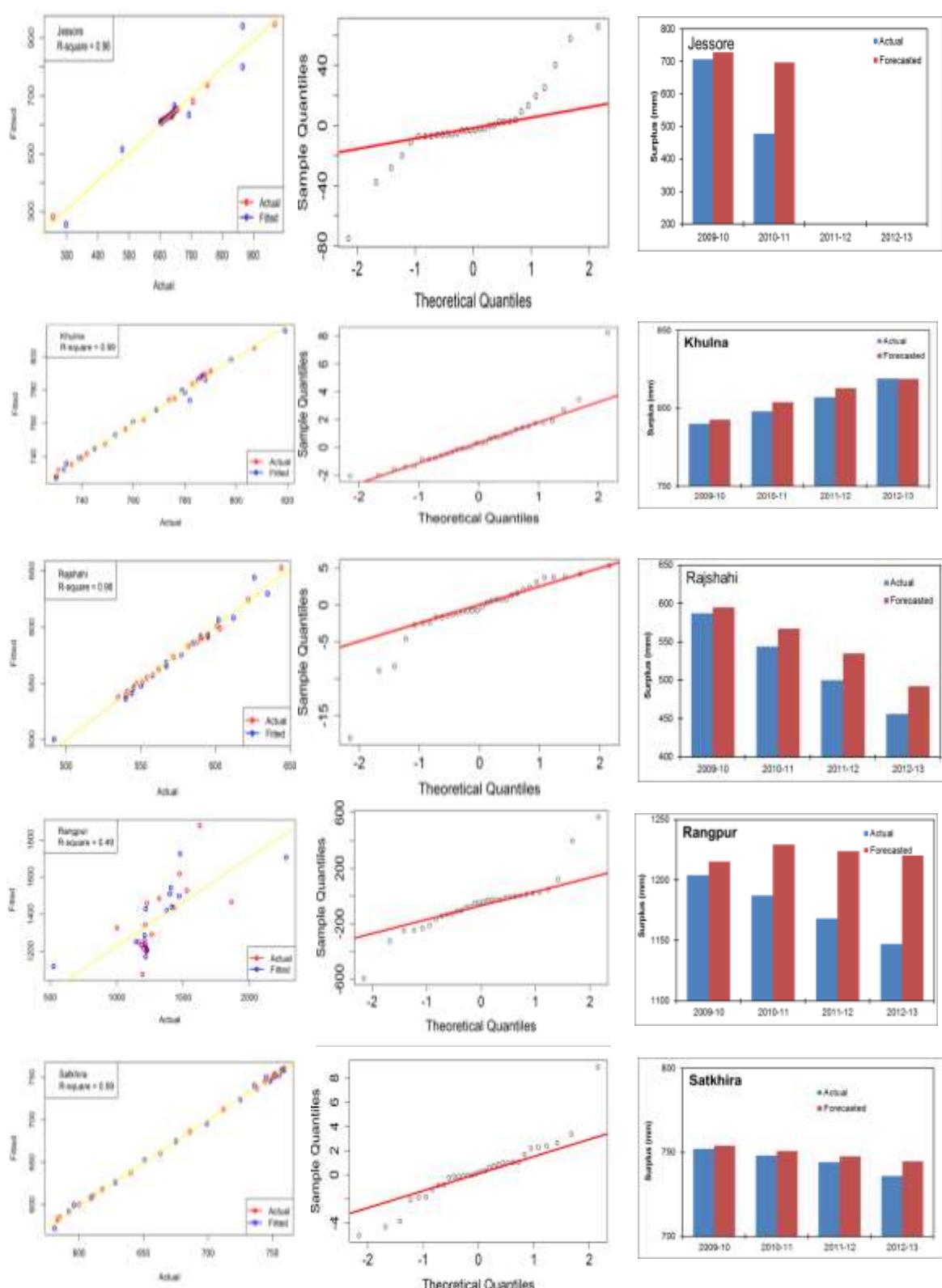


Figure S8. (Continued)

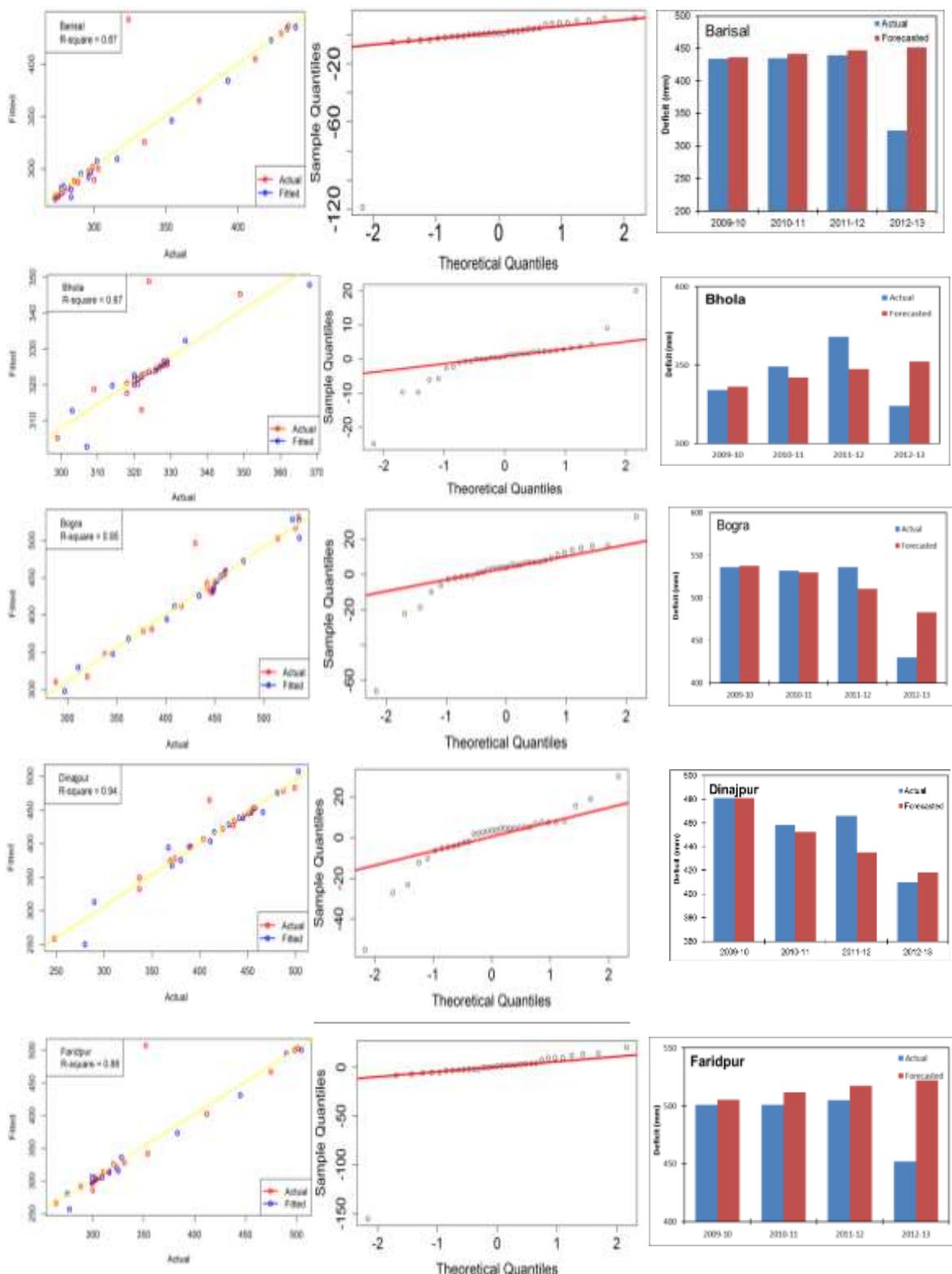


Figure S9. Plot of best wavelet ARIMA model of annual deficit first panel represents actual versus fitted values for the period of 1981-82 to 2012-2013, second panel is normal Q-Q plot of residual of the model, and third panel shows actual, fitted and forecasted values for the period of 2009-2010 to 2012-13.

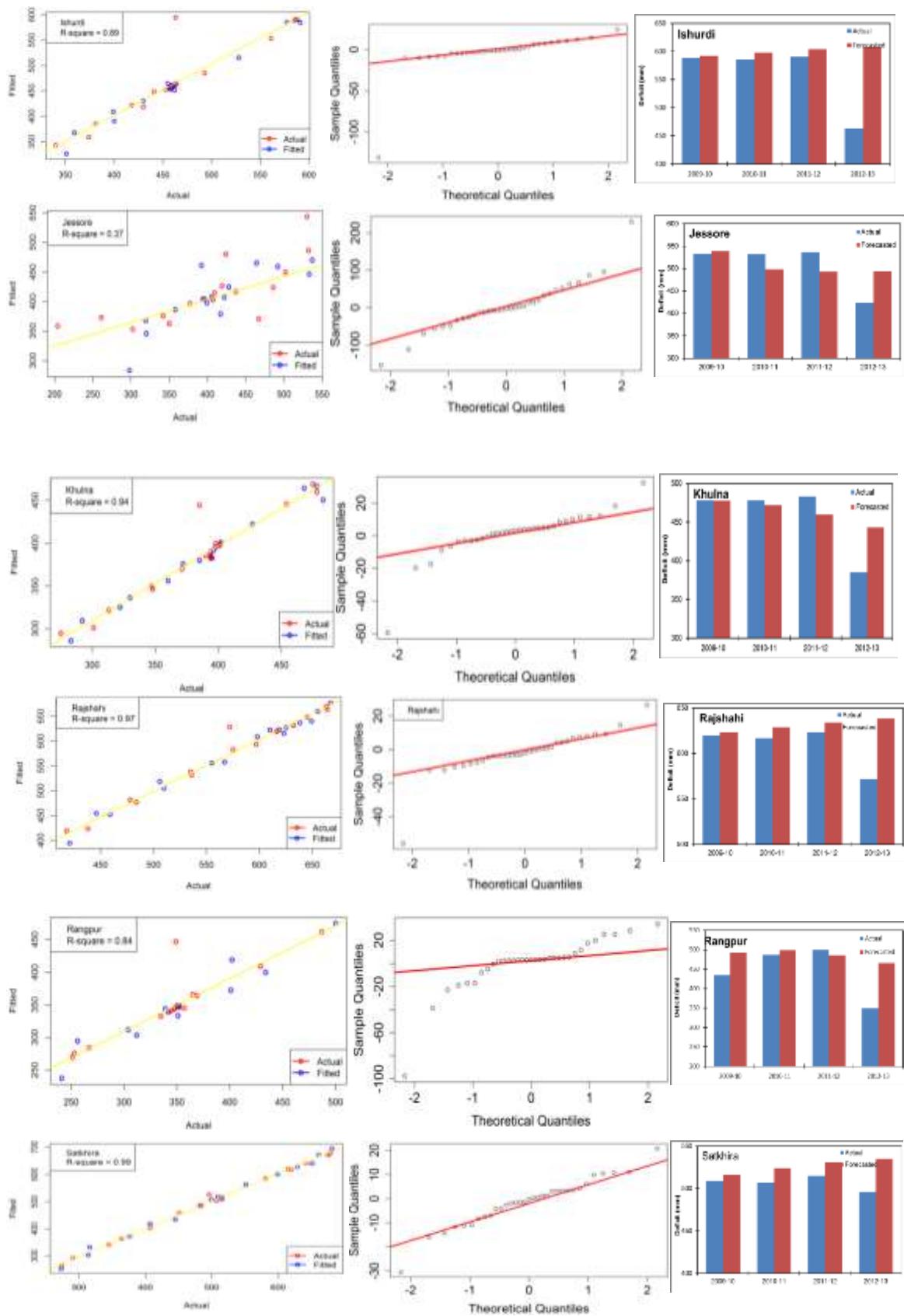


Figure S9. (Continued)

Table S1: Z statistic of MK or MMK of original time series, approximation and different models of P_{ET} of DWT (the dominant components are bold and asterisk for significant at 5% level)

Stations	Barisal			Bhola			Bogra			Dinajpur		
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE
Original	0.72			2.37*			-0.2			-0.98		
A	-1.80	0.24	11.56	-1.8	-0.15	17.15	-1.8	0.83	4.66	-1.8	0.83	3.47
D1	0.91	0.5	0.5	2.02*	0.25	0.68	1.16	-0.42	5.1	-	-0.31	7.7
D2	-0.03	0.17	1.51	0.61	0.21	0.94	0.16	0.60	3.7	0.43	0.63	8.82
D3	0.45	0.17	1.51	0.46	0.21	0.94	1.08	0.60	3.7	0.90	0.63	8.82
D4	0.76	0.37	3.93	1.2	0.8	7.28	1.14	0.13	3.76	2.10*	-0.03	13.35
D1+A	-0.89	0.35	0.71	1.58	0.11	0.72	-2.35*	0.90	0.54	-1.7	0.95	0.44
D2+A	-1.51	0.14	2.75	0.48	0.13	1.05	-1.54	0.89	0.62	-2.05*	0.93	1.25
D3+A	-0.66	0.50	1.90	0.31	0.14	1.23	-1.91	0.89	5.72	-1.56	0.95	3.03
D4+A	0.06	0.53	9.99	0.9	0.77	8.71	-0.34	0.58	7.32	-1.79	0.85	2.41
D1+D2+A	-0.89	0.35	0.82	0.73	0.39	0.68	-1.12	0.88	0.77	-1.76	0.97	0.18
D1+D3+A	-0.81	0.58	0.88	0.79	0.31	0.69	-1.33	0.87	0.89	-1.51	0.98	0.38
D1+D4+A	0.91	0.63	1.16	2.29*	0.83	0.35	0.24	0.87	0.53	-1.15	0.97	0.2
D2+D3+A	-0.46	0.43	1.24	1.01	0.08	2.42	-1.33	0.89	1.1	-1.37	0.96	1.35
D2+D4+A	0.54	0.5	2.84	2.36*	0.77	0.68	0.10	0.88	0.6	-1.27	0.94	0.85
D3+D4+A	0.56	0.85	2.04	1.83	0.90	0.74	-0.30	0.87	1.37	-1.54	0.96	2.1
	Faridpur			Ishurdi			Jessore			Khulna		
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE
Original	-0.51			-0.22			0.2			-1.35		
A	-1.8	0.75	7.11	-1.8	0.92	4.49	-1.8	0.79	4.46	-1.8	0.49	6.59
D1	2.24*	-0.22	3.09	3.25*	0.26	4.19	0.45	-0.14	6.00	0.12	-0.28	3.34
D2	-	0.47	2.3	-0.16	0.62	4.44	0.28	0.61	4.51	-0.11	0.3	4.49
D3	0.40	0.47	2.3	0.5	0.62	4.44	0.87	0.61	4.51	-0.01	0.3	4.49
D4	1.15	-0.33	4.62	1.24	0.03	6.26	0.71	0.63	3.88	0.44	0.21	11.19
D1+A	-1.57	0.92	0.36	-1.38	0.85	0.75	-2.77	0.56	1.95	-1.90	0.7	0.86
D2+A	-1.28	0.85	0.94	-1.74	0.88	1.11	-1.44	0.72	1.32	-2.35*	0.65	2.36
D3+A	-0.95	0.93	0.87	-1.48	0.88	3.71	-1.32	0.19	2.98	-1.41	0.93	1.08
D4+A	-0.96	0.51	10.5	-0.71	0.87	5.33	0.01	0.84	4.51	-1.52	0.54	5.44
D1+D2+A	-1.31	0.89	0.33	-1.45	0.88	0.41	-1.14	0.64	1.51	-1.77	0.72	0.76
D1+D3+A	-0.81	0.95	0.19	-1.06	0.79	0.97	-0.80	0.13	3.14	-1.24	0.98	0.11
D1+D4+A	-0.47	0.78	0.65	-0.12	0.95	0.2	0.29	0.92	1.33	-1.86	0.72	0.8
D2+D3+A	-0.94	0.95	0.86	-1.3	0.83	1.91	-0.88	0.48	2.35	-1.16	0.92	0.55
D2+D4+A	-0.91	0.79	1.19	-0.62	0.97	0.82	0.42	0.93	0.55	-1.8	0.72	1.65
D3+D4+A	-0.49	0.91	0.95	-0.6	0.93	3.73	-0.32	0.88	3.14	-1.39	0.86	0.65
	Rajshahi			Rangpur			Satkhira					
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE			
Original	-1.52			-0.79			-2.07					
A	-1.8	0.97	0.52	-1.8	0.68	6.86	-1.8	0.99	0.48			
D1	-	-0.1	12.77	-	0.28	3.74	NA	-0.08	12.88			
D2	1.18	0.27	15.54	-	0.44	4.95	0.32	0.8	12.19			
D3	-0.01	0.27	15.54	0.71	0.44	4.95	-2.25	0.8	12.19			
D4	1.38	-0.2	11.47	2.25*	0.02	8.1	-0.98	0.24	6.7			
D1+A	-1.85	0.96	0.38	-2.22*	0.89	0.47	-1.88	0.99	0.15			
D2+A	-2.01	0.96	0.65	-1.88	0.88	1.03	-1.67	0.99	0.24			
D3+A	-1.86	0.98	0.47	-1.3	0.94	1.82	-1.97	0.98	0.98			
D4+A	-1.18	0.96	0.45	-1.37	0.81	1.8	-1.81	0.98	1.03			
D1+D2+A	-1.98*	0.97	0.51	-1.99*	0.88	0.53	-1.63	0.99	0.4			
D1+D3+A	-1.69	0.97	0.16	-1.67	0.97	0.23	-1.82	0.99	0.14			
D1+D4+A	-1.06	0.97	0.26	-1.28	0.92	0.34	-1.77	0.99	0.19			
D2+D3+A	-1.94	0.96	0.37	-1.11	0.99	0.26	-1.65	0.99	0.27			
D2+D4+A	-1.38	0.97	0.34	-1	0.89	0.74	-2.17*	1	0.05			
D3+D4+A	-1.39	0.97	1.02	-0.81	0.97	0.5	-1.79	0.98	1.2			

Table S2: Z statistic of MK or MMK of original time series, approximation and different models of A_{ET} of DWT (the dominant components are bold and asterisk for significant at 5% level)

Stations	Barisal			Bhola			Bogra			Dinajpur		
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE
Original	-1.35			-0.21			0.31			-0.68		
A	-1.8	0.23	12.94	1.8	0.22	9.59	1.8	-0.03	16.07	-1.8	0.42	14.63
D1	0.57	0.01	1.32	-0.1	0.48	1.74	-0.05	0.55	0.1	0.04	0.28	0.34
D2	-0.34	-0.15	1.38	0.7	0.4	0.83	0.54	0.18	1.59	-0.24	0.49	0.3
D3	1.82	-0.15	1.38	0.16	0.4	0.83	0.8	0.18	1.59	0.53	0.49	0.3
D4	-1.2	0.87	4.34	-1.38	0.82	3.15	1.38	0.47	6.77	-2.26	0.33	2.95
D1+A	-1.33	0.56	0.81	0.69	0.2	1.07	0.02	0.48	0.14	0.04	0.3	0.34
D2+A	-1.93	0.57	1.89	3.99	0.03	1.02	0.67	0.18	1.65	-0.66	0.55	0.33
D3+A	-1.41	0.71	3.54	2.18	0.08	3.03	1.14	0.38	0.63	0.37	0.66	0.65
D4+A	-1.86	0.86	4.5	-0.81	0.91	1.83	1.65	0.46	6.74	-2.64	0.37	3.55
D1+D2+A	-1.09	0.65	0.98	0.76	0.5	0.78	-0.72	0.58	0.11	-0.24	0.54	0.25
D1+D3+A	-0.21	0.63	0.78	0.66	0.57	0.61	0.19	0.7	0.08	0.28	0.71	0.24
D1+D4+A	-1.86	0.92	0.38	-0.37	0.9	0.18	0.24	0.6	0.09	-0.86	0.54	0.41
D2+D3+A	-0.87	0.71	1.62	1.46	0.44	1.13	1.32	0.42	1.28	-0.06	0.65	0.52
D2+D4+A	-2.5	0.92	0.52	-0.35	0.89	0.62	1.86	0.41	1.4	-0.97	0.39	1.06
D3+D4+A	-1.64	0.92	1.33	-0.74	0.9	2.13	1.55	0.64	0.57	-1	0.78	0.83
	Faridpur			Ishurdi			Jessore			Khulna		
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE
Original	-1.91			-2.9*			-0.36			-1.82		
A	-1.8	0.73	7.32	-1.8	0.43	5.94	-1.8	0.62	8.07	1.8	0.2	14.81
D1	0.41	0.23	2.62	-0.24	0.39	4.94	0.05	-0.02	2.02	-0.18	0.43	0.47
D2	-0.4	-0.36	1.75	-0.72	0.04	2.55	0.89	0.41	3.31	-2.22*	0.26	1.51
D3	0.93	-0.36	1.75	-0.08	0.04	2.55	0.57	0.41	3.31	-1.1	0.26	1.51
D4	-1.65	0.55	2.04	-2.23*	0.36	2.36	0.49	0.24	7.2	-1.3	0.78	6.23
D1+A	-0.99	0.71	0.47	-3.17*	0.51	1.81	-1.99	0.8	0.51	-0.08	0.44	0.46
D2+A	-1.61	0.81	1.11	-2.17*	0.70	0.52	-1.35	0.76	0.88	-1.3	0.16	1.35
D3+A	-1.73	0.76	7.52	-1.54	0.70	1.17	-1.25	0.7	1.85	0.02	-0.34	2.09
D4+A	-7.98*	0.87	7.44	-4.05*	0.60	2.5	-0.40	0.55	10.05	-1.12	0.81	6.76
D1+D2+A	-1.05	0.82	0.24	-1.86	0.76	0.57	-1.90	0.76	0.32	-0.7	0.31	0.57
D1+D3+A	-0.6	0.69	0.53	-1.35	0.65	0.72	-1.28	0.78	0.24	-0.37	0.27	0.57
D1+D4+A	-2.35*	0.91	0.18	-2.71*	0.55	0.94	-0.96	0.84	0.74	-1.41	0.95	0.25
D2+D3+A	-1.43	0.71	1.68	-1.49	0.74	0.27	-0.89	0.72	0.68	-1.19	0.06	1.87
D2+D4+A	-5.18*	0.93	1.49	-3.09*	0.85	0.73	-0.13	0.83	0.65	-1.68	0.88	0.81
D3+D4+A	-4.1*	0.86	3.9	-4.41*	0.71	1.83	-0.58	0.85	1.92	-1.28	0.86	7.69
	Rajshahi			Rangpur			Satkhira					
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE			
Original	-0.73			-0.68			-1.49					
A	-1.80	0.36	11.28	-1.8	0.75	11.85	-1.80	0.38	11.67			
D1	-0.44	0.56	0.3	0.89	-0.11	1.65	0.18	0.25	0.65			
D2	-0.54	0.25	0.23	-0.45	-0.24	1.58	0.21	-0.35	0.91			
D3	0.78	0.25	0.23	-0.42	-0.24	1.58	-1.08	-0.35	0.91			
D4	-1.45	00	2.30	-0.59	-0.03	14.6	-1.13	0.77	2.16			
D1+A	-0.96	0.56	0.20	-2.10*	0.83	0.55	-0.66	0.52	0.33			
D2+A	-2.92*	0.61	1.22	-3.00*	0.81	1.52	-1.22	0.30	1.45			
D3+A	-1.73	0.65	2.03	-2.28*	0.89	1.00	-1.92	0.52	2.20			
D4+A	-2.24*	0.44	12.79	-2.38*	0.79	11.09	-3.78*	0.74	5.83			
D1+D2+A	-1.05	0.75	0.10	-0.31	0.83	0.41	-0.87	0.67	0.20			
D1+D3+A	-0.37	0.86	0.11	-0.79	0.94	0.15	-0.73	0.75	0.28			
D1+D4+A	-1.41	0.62	0.28	-3.40*	0.79	0.62	-1.77	0.86	0.16			
D2+D3+A	-			-1.25	0.96	0.43	-					
D2+D4+A	-2.91*	0.63	1.14	-3.20*	0.80	1.59	-9.74*	0.78	1.13			
D3+D4+A	-1.73	0.63	3.21	-2.59*	0.89	1.04	-3.95*	0.88	3.08			

Table S3: Z statistic of MK or MMK of original time series, approximation and different models of surplus of DWT (the dominant components are bold and asterisk for significant at 5% level)

Stations	Barisal			Bhola			Bogra			Dinajpur		
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE
Original	-1.3			-1.23			-1.43			-1.15		
A	1.80	-0.40	16.29	-1.80	0.32	10.42	-1.80	0.48	15.91	1.80	-0.20	15.03
D1	0.02	0.36	0.30	-0.41	0.37	0.47	-0.21	0.48	0.48	-0.28	0.50	0.26
D2	-0.28	0.41	0.37	-0.47	0.23	0.69	0.66	0.41	0.50	-0.11	0.11	0.36
D3	-0.64	0.41	0.37	-0.09	0.23	0.69	-0.06	0.41	0.50	0.11	0.11	0.36
D4	-2.31*	0.32	2.30	-1.35	0.76	1.08	-0.54	0.53	10.17	-2.32*	0.59	2.25
D1+A	0.02	0.36	0.30	-0.37	0.37	0.47	-0.34	0.58	0.49	-0.17	0.32	0.28
D2+A	-0.11	0.35	0.31	-0.47	0.23	0.69	0.41	0.57	0.34	0.37	0.05	0.52
D3+A	-0.70	0.35	2.23	-0.11	0.46	2.32	-0.34	0.52	1.27	0.63	0.38	1.92
D4+A	-2.20*	0.31	2.19	-1.33	0.76	1.11	-0.64	0.56	9.35	-1.39	0.54	1.60
D1+D2+A	-1.85	0.79	0.11	-1.75	0.56	0.22	0.14	0.47	0.42	-		
D1+D3+A	-0.54	0.76	0.17	-1.43	0.41	0.48	-			0.02	0.56	0.29
D1+D4+A	-			-4.68*	0.64	0.22	-			-1.70	0.71	0.19
D2+D3+A	-0.89	0.54	0.82	-0.69	0.38	1.12	-0.55	0.66	0.65	0.67	0.47	1.80
D2+D4+A	-0.93	0.32	0.57	-0.95	0.76	0.22	-1.49	0.75	0.65	-1.24	0.69	0.28
D3+D4+A	-1.83	0.52	1.93	-1.56	0.84	0.96	-2.26*	0.91	1.16	-0.96	0.85	1.50
	Faridpur			Ishurdi			Jessore			Khulna		
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE
Original	-0.62			-0.15			-0.28			0.21		
A	-1.80	0.43	13.05	1.80	0.23	14.41	1.80	-0.14	15.79	1.80	-0.46	19.60
D1	-0.21	0.12	0.14	-0.37	0.24	0.21	-0.31	0.02	0.51	-0.08	0.06	0.65
D2	-0.60	0.31	0.16	-1.01	0.49	0.86	0.41	0.13	0.75	0.66	0.47	0.86
D3	-4.53*	0.31	0.16	0.64	0.49	0.86	-1.20	0.13	0.75	-0.90	0.47	0.86
D4	-0.54	0.67	2.80	-1.46	0.30	3.29	-0.31	0.53	3.62	0.96	0.75	2.66
D1+A	-0.81	0.10	0.13	0.61	0.59	0.11	0.50	0.01	0.98	-0.17	0.04	0.65
D2+A	-0.89	0.24	0.22	0.02	0.50	0.71	1.30	0.14	2.49	1.31	0.26	1.72
D3+A	-1.22	0.58	0.91	1.64	0.46	1.56	-0.47	0.65	1.58	-0.41	0.58	2.35
D4+A	-0.79	0.69	3.49	0.84	0.35	3.99	0.73	0.48	3.70	0.95	0.71	2.42
D1+D2+A	-			-0.37	0.75	0.08	0.15	0.12	0.59	0.05	0.00	0.85
D1+D3+A	-1.47	0.52	0.08	0.25	0.75	0.07	-0.21	0.71	0.47	-0.78	0.27	0.70
D1+D4+A	-			-			1.58	0.54	0.46	0.76	0.89	0.12
D2+D3+A	-1.63	0.49	0.25	1.32	0.56	0.61	-0.01	0.73	1.51	0.30	0.62	1.22
D2+D4+A	-0.79	0.67	0.41	-0.19	0.67	0.33	0.86	0.55	1.03	1.39	0.80	0.85
D3+D4+A	-1.08	0.75	2.29	1.79	0.54	0.99	-0.47	0.86	1.06	0.52	0.92	1.01
	Rajshahi			Rangpur			Satkhira					
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE			
Original	-1.10			-1.09			0.66					
A	1.80	0.04	18.35	-1.80	0.57	14.39	1.80	0.51	11.40			
D1	-0.57	0.48	0.16	-0.02	0.00	0.58	-0.28	0.32	0.69			
D2	-2.24*	0.60	0.82	0.89	0.49	0.56	0.81	-0.14	0.85			
D3	0.36	0.60	0.82	-1.53	0.49	0.56	-0.81	-0.14	0.85			
D4	-2.01*	0.58	1.75	-2.10*	0.53	2.78	1.36	0.74	7.61			
D1+A	0.02	0.38	0.47	-1.12	0.45	0.96	3.03*	0.84	0.15			
D2+A	0.50	0.32	1.07	-0.55	0.58	1.19	1.91	0.69	3.48			
D3+A	2.87*	0.11	11.42	-2.55*	0.74	3.43	2.29*	0.70	6.15			
D4+A	-0.33	0.57	2.12	-3.50*	0.68	5.54	2.28*	0.67	6.91			
D1+D2+A	0.04	0.45	0.50	0.02	0.39	0.36	0.70	0.91	0.10			
D1+D3+A	0.43	0.49	0.60	-1.12	0.70	0.28	1.09	0.93	0.10			
D1+D4+A	-0.73	0.59	0.35	-3.03*	0.77	0.86	1.50	0.86	0.15			
D2+D3+A	0.41	0.35	1.02	-0.95	0.73	0.86	1.83	0.85	3.82			
D2+D4+A	-0.50	0.68	0.74	-1.64	0.75	1.24	2.42*	0.80	2.28			
D3+D4+A	-0.22	0.57	3.71	-2.94*	0.80	3.48	1.85	0.80	5.20			

Table S4: Z statistic of MK or MMK of original time series, approximation and different models of surplus of DWT (the dominant components are bold and asterisk for significant at 5% level)

Stations	Barisal			Bhola			Bogra			Dinajpur		
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE
Original	2.40*			1.18			0.44			-0.49		
A	1.80	0.18	15.33	-1.80	0.15	10.99	-1.80	0.67	9.25	-1.80	0.52	8.10
D1	-0.29	-0.50	1.98	0.07	-0.05	1.94	1.03	0.19	1.59	-0.03	0.47	1.54
D2	1.56	0.16	1.81	-1.04	0.38	0.95	0.73	0.32	2.05	0.89	-0.08	3.88
D3	1.22	0.16	1.81	0.52	0.38	0.95	0.94	0.32	2.05	0.77	-0.08	3.88
D4	1.30	0.91	4.93	1.38	0.86	3.20	1.25	0.30	2.31	2.17*	0.10	6.94
D1+A	3.48*	0.14	2.02	-0.65	-0.14	1.36	-1.41	0.79	0.67	-1.77	0.65	1.00
D2+A	-			-2.55*	-0.11	1.67	-1.49	0.80	1.89	-1.73	0.63	2.21
D3+A	1.77	0.44	3.57	-1.22	-0.35	3.40	-1.36	0.81	6.50	-1.27	0.75	1.93
D4+A	1.78	0.91	3.78	0.98	0.91	3.31	-0.30	0.68	8.15	-0.24	0.56	2.48
D1+D2+A	1.25	0.67	1.58	-0.37	0.41	0.90	-1.31	0.80	0.70	-1.44	0.73	0.60
D1+D3+A	0.92	0.38	1.46	-0.26	-0.08	1.20	-0.79	0.81	0.39	-1.18	0.93	0.48
D1+D4+A	2.16*	0.91	0.81	0.83	0.93	0.15	0.63	0.87	0.28	-0.79	0.72	0.69
D2+D3+A	1.20	0.41	3.15	-0.70	0.21	1.35	-1.05	0.81	1.59	-1.41	0.91	0.78
D2+D4+A	2.25*	0.90	0.75	0.55	0.95	1.61	0.11	0.88	1.05	-0.32	0.69	1.28
D3+D4+A	1.86	0.88	2.19	1.14	0.89	2.39	-0.30	0.91	3.41	-0.20	0.72	1.02
	Faridpur			Ishurdi			Jessore			Khulna		
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE
Original	2.14*			1.28			1.77			1.17		
A	1.80	0.36	10.81	-1.80	0.81	16.32	-1.80	0.15	17.72	-1.80	0.58	10.86
D1	-			-			1.54	0.45	0.47	-		
D2	1.11	0.01	0.86	0.62	0.82	0.32	0.55	0.55	0.45	1.30	0.67	1.27
D3	0.27	0.01	0.86	0.86	0.82	0.32	0.83	0.55	0.45	0.17	0.67	1.27
D4	1.44	0.64	1.37	1.12	-0.03	4.10	0.80	0.70	11.39	1.00	0.41	7.16
D1+A	0.02	0.12	0.62	-2.66*	0.84	2.18	-1.32	0.13	1.87	-1.88	0.46	0.66
D2+A	1.87	0.15	0.66	-0.42	0.86	0.83	-0.19	0.28	1.34	-1.08	0.63	0.99
D3+A	1.07	0.37	1.13	-0.55	0.73	3.05	-0.09	-0.54	4.09	-1.43	0.17	5.66
D4+A	1.94	0.69	1.14	0.04	0.41	13.27	0.30	0.67	15.60	-0.10	0.71	11.79
D1+D2+A	0.63	0.32	0.40	-0.18	0.91	0.40	0.60	0.49	0.79	-0.37	0.63	0.54
D1+D3+A	1.97*	0.46	0.61	-0.08	0.61	1.12	-0.08	-0.18	1.78	-0.63	0.44	0.68
D1+D4+A	1.80	0.76	0.50	0.60	0.72	3.14	1.00	0.75	3.77	0.24	0.77	1.22
D2+D3+A	1.53	0.21	1.16	0.25	0.86	0.26	0.43	0.05	1.33	-0.41	0.65	1.04
D2+D4+A	2.11*	0.66	0.97	0.80	0.91	0.40	1.58	0.84	0.40	0.24	0.85	1.01
D3+D4+A	2.70*	0.77	1.74	0.85	0.69	2.79	1.39	0.63	4.35	0.22	0.66	3.44
	Rajshahi			Rangpur			Satkhira					
	Z	Co	MSE	Z	Co	MSE	Z	Co	MSE			
Original	-0.63			0.26			-1.52					
A	-1.80	0.93	5.40	-1.80	-0.34	13.52	-1.80	0.99	1.64			
D1	-			-			-0.93	0.30	6.18			
D2	0.70	0.27	4.35	0.83	0.40	2.05	0.70	0.73	10.11			
D3	-0.34	0.27	4.35	0.60	0.40	2.05	-1.98	0.73	10.11			
D4	1.37	-0.14	6.94	2.29*	0.17	3.97	0.33	0.07	4.85			
D1+A	-1.86	0.88	0.50	-3.56*	-0.30	1.30	-1.95	0.96	0.60			
D2+A	-2.07*	0.89	1.43	-0.49	0.10	1.03	-1.84	0.96	0.75			
D3+A	-2.02*	0.93	6.99	0.05	0.72	0.41	-2.11*	0.98	2.09			
D4+A	-1.09	0.92	5.65	0.14	-0.09	3.47	-1.25	0.95	1.78			
D1+D2+A	-1.61	0.88	0.36	-1.09	0.12	0.81	-1.80	0.94	0.80			
D1+D3+A	-1.83	0.91	0.35	-0.05	0.76	0.26	-1.93	0.96	0.40			
D1+D4+A	-1.18	0.95	0.42	-1.57	-0.18	1.48	-1.29	0.98	0.51			
D2+D3+A	-1.68	0.89	1.07	0.12	0.90	0.15	-1.88	0.98	0.31			
D2+D4+A	-1.11	0.94	0.80	0.59	0.24	1.16	-1.57	0.99	0.16			
D3+D4+A	-1.05	0.94	5.09	0.46	0.76	0.48	-1.28	0.95	1.82			

Table S5: Parameter estimation of denoised ARIMA model for WBC

P_{ET}						
Stations	Coefficient					
	AR1	AR2	AR3	MA1	MA2	MA3
Barisal	-0.3	-0.6		1.9	1.0	
Bhola				1.4	0.4	
Bogra	0.8			1.4	0.4	
Dinajpur	1.7	-0.8		1.0		
Faridpur	1.7	-0.8		-1.0		
Ishurdi	0.6					
Jessore	0.6			0.6		
Khulna	0.7					
Rajshahi	0.0					
Rangpur	1.4	-0.7		0.7	0.8	0.9
Satkhira				1.5	0.0	-0.5
A_{ET}						
Barisal				-1.6	0.9	
Bhola				0.2		
Bogra				0.3	0.8	0.6
Dinajpur	0.8					
Faridpur	1.3	-0.4				
Ishurdi	0.9			0.5		
Jessore				-0.1		
Khulna	1.2	-0.3				
Rajshahi	0.9					
Rangpur	0.1	-0.9	0.7	-0.6	0.7	1.0
Satkhira	0.9			0.5		
Surplus						
Barisal	0.8			1.0		
Bhola	1.4	-0.5				
Bogra						
Dinajpur				1.6	1.0	
Faridpur	0.8			-0.1	1.0	
Ishurdi	-0.3			1.0		
Jessore	1.4	-0.9		0.6	0.6	1.0
Khulna	1.3	-0.4				
Rajshahi	0.0			1.0		
Rangpur	-1.1	-0.9	-0.4	-0.8		
Satkhira	1.5	-0.6				
Deficit						
Barisal	0.6					
Bhola	1.3	-0.9		-0.7	0.9	0.1
Bogra	1.9	-1.0		-1.0	0.0	
Dinajpur	1.1	-0.5		0.6	0.7	0.9
Faridpur	0.7					
Ishurdi	0.7					
Jessore	0.4			0.4		
Khulna	1.9	-1.0		-1.0		
Rajshahi	0.8					
Rangpur	1.4	-0.9		0.3		
Satkhira		0.8		1.0		

R Codes for MK, MMK test and Sen's Slope

```
MMKTest <- function(x, ci) {  
  x = x  
  z = NULL  
  z0 = NULL  
  pval = NULL  
  pval0 = NULL  
  S = 0  
  Tau = NULL  
  essf = NULL  
  ci = ci  
  if (is.vector(x) == FALSE) {  
    stop("Input data must be a vector")  
  }  
  if (any(is.finite(x) == FALSE)) {  
    x[-c(which(is.finite(x) == FALSE))] -> x  
    warning("The input vector contains non-finite numbers. An attempt was made to remove them")  
  }  
  n <- length(x)  
  for (i in 1:(n-1)) {  
    for (j in (i+1):n) {  
      S = S + sign(x[j]-x[i])  
    }  
  }  
  acf(rank(lm(x ~ I(1:n))$resid), lag.max=(n-1), plot=FALSE)$acf[-1] -> ro  
  qnorm((1+ci)/2)/sqrt(n) -> sig  
  rep(NA,length(ro)) -> rof  
  for (i in 1:(length(ro))) {  
    if(ro[i] > sig || ro[i] < -sig) {  
      rof[i] <- ro[i]  
    } else {  
      rof[i] = 0  
    }  
  }  
}
```

```

}

}

2 / (n*(n-1)*(n-2)) -> cte

ess=0

for (i in 1:(n-1)) {

  ess = ess + (n-i)*(n-i-1)*(n-i-2)*rof[i]

}

essf = 1 + ess*cte

var.S = n*(n-1)*(2*n+5)*(1/18)

if(length(unique(x)) < n) {

  unique(x) -> aux

  for (i in 1:length(aux)) {

    length(which(x == aux[i])) -> tie

    if (tie > 1) {

      var.S = var.S - tie*(tie-1)*(2*tie+5)*(1/18)

    }

  }

}

VS = var.S * essf

if (S == 0) {

  z = 0

  z0 = 0

}

if (S > 0) {

  z = (S-1)/sqrt(VS)

  z0 = (S-1)/sqrt(var.S)

} else {

  z = (S+1)/sqrt(VS)

  z0 = (S+1)/sqrt(var.S)

}

pval = 2*pnorm(-abs(z))

pval0 = 2*pnorm(-abs(z0))

```

```

Tau = S/(.5*n*(n-1))

rep(NA, times=(n^2-n)/2) -> V

k = 0

for (i in 2:n) {

  for (j in 1:(n-1)) {

    k = k+1

    V[k] = (x[i]-x[j])/(i-j)

  }

}

median(na.omit(V)) -> slp

return(list("Mann-Kendall.Z" = z0, "Mann-Kendall_p.value" = pval0, "Modified_Mann-Kendall.Z" =
z,
"Modified_Mann-Kendall_p.value" = pval, "Tau.value" = Tau, "Sen's Slope" = slp))

}

```