This paper is contributed to theme I: Issues and challenges of global changes impacts on river basins and aquifer systems.

Effects of El-Nino Southern Oscillation and Pacific Decadal Oscillation on Streamflow in the Zayandeh-rood River Basin

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Abstract

Understanding the ocean-atmospheric interactions that results in climate modes will not only improve weather and climate forecasting capabilities, but could also beneficially lead us to more accurate hydrological forecasts. Therefore, understanding and identifying the effects of these phenomena on hydrological and meteorological parameters of different basins throughout the world is of great importance. It is recognized that combining two well-identified climate signals, mainly El-Nino Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) information could enhance the skill of hydrological forecasting.

ENSO is one of the most prominent known sources of inter-annual climate variability around the world that is the result of a cyclic warming and cooling of the surface of the central and eastern Pacific Ocean. This region of the ocean is normally colder than its equatorial location, mainly due to the influence of northeasterly trade winds. The condition would be vice versa in the opposite phase.

PDO is a pattern of Pacific climate variability that shifts phases on inter-decadal time scale, usually about 20 to 30 years and is detected as warm or cool surface waters in the Pacific Ocean. It is characterized by changes in sea surface temperature, sea level pressure, and wind patterns. During a "warm" or "positive" phase, the west Pacific becomes cool and part of the eastern ocean warms; during a "cool" or "negative" phase, the opposite pattern occurs.

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In this research, inter-annual and inter-decadal climate variability in form of ENSO and PDO are analyzed to assess the impacts of these large-scale climate patterns on streamflow of main tributaries in Zayandeh-rood River Basin, one of the major river basins in the central plateau of Iran. For this purpose, monthly, seasonal and annual cross correlation coefficients of Southern Oscillation Index (SOI) and Pacific Decadal Oscillation Index with the Basin's historical streamflow records for three main rivers with different lag have been determined.

The results indicate that Koohrang River has a meaningful correlation with the SOI and PDO Indices of simultaneous year, as well as the previous year. In addition, spring streamflow of this river has a high correlation with spring PDO of the same season and PDO of the previous fall and summer. The winter streamflow of Koohrang River is highly correlated with the simultaneous spring SOI, previous spring, summer and fall SOI. The monthly correlation analysis indicates that there is an inverse relation between the monthly streamflow of Koohrang River and monthly SOI up to a 9 month lag. Also, it was found that the streamflow in the basin is directly related to PDO and inversely related to SOI.

Keywords: Streamflow, El-Nino Southern Oscillation (ENSO), Pacific Decadal Oscillation, Correlation Analysis, Zayandeh-rood River Basin

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Table 1. Annual Correlation Coefficient Between Rivers Streamflow and SOI/PDO Indices up to Two Lags

	Pelasjan River		Zayandeh-rood River		Koohrang River	
Lag (K)	Correl Coeff. With PDO	Correl Coeff. With SOI	Correl Coeff. With PDO	Correl Coeff. With SOI	Correl Coeff. With PDO	Correl Coeff. With SOI
0	0.265	-0.187	**0.446****	-0.231	**0.469****	**-0.449****
1	0.121	0.121	0.202	-0.180	**0.381****	**-0.639****
2	-0.016	-0.016	-0.015	0.097	-0.078	-0.265

* Meaningful at 95% level ** Meaningful at 99% level

Table 2. Monthly Correlation Coefficient Between Rivers Streamflow and PDO/SOI Indices Up to Twelve Lag (Correlation of Each Month with another k-lagged Month)

	Pelasjan River		Zayande-rood River		Koohrang River	
Lag (K)	Correl.Coeff. With PDO	Correl.Coeff. With SOI	Correl.Coeff. With PDO	Correl.Coeff. With SOI	Correl.Coeff. With PDO	Correl.Coeff. With SOI
0	**0.119****	-0.087	**0.224****	**-0.112****	**0.360****	**-0.131***
1	0.063	**-0.150****	**0.197****	**-0.180****	**0.319****	**-0.200****
2	0.021	-0.082	**0.121****	**-0.140****	**0.217****	**-0.215****
3	-0.028	-0.068	0.038	**-0.108***	0.104	**-0.210****
4	-0.055	-0.088	-0.042	-0.095	0.012	**-0.210****
5	-0.032	-0.025	-0.082	-0.051	-0.052	**-0.191****
6	0.048	-0.007	-0.056	-0.028	-0.058	**-0.173****
7	**0.114****	-0.008	0.001	-0.014	-0.015	**-0.190****
8	**0.144****	-0.015	0.05	-0.004	0.075	**-0.168****
9	**0.129****	0.004	**0.096***	0.003	**0.177****	**-0.141***
10	0.088	-0.018	**0.112***	-0.001	**0.233****	-0.122
11	0.085	-0.03	**0.160****	-0.023	**0.255****	-0.117
12	0.059	-0.048	**0.166****	-0.076	**0.252****	**-0.149***

* Meaningful at 95% level ** Meaningful at 99% level

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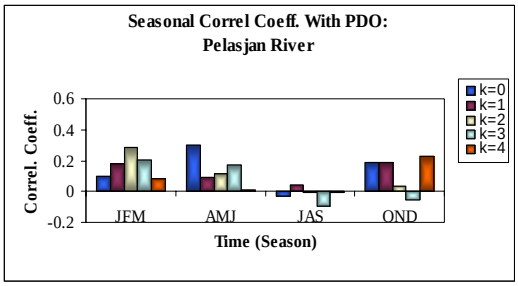
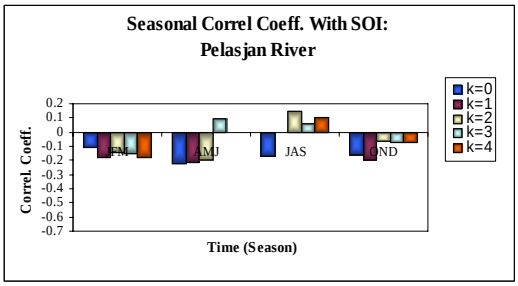
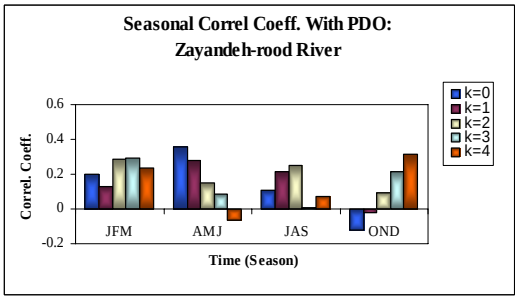
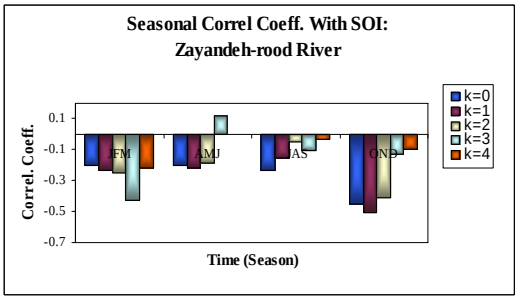
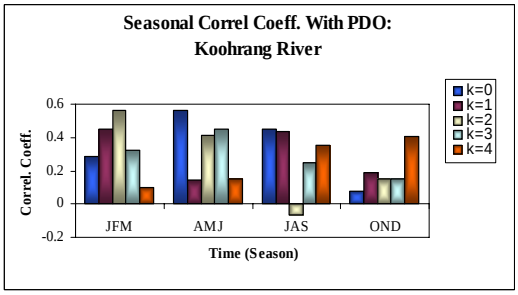
Graph1. Seasonal Correlation Coefficient Between Rivers Streamflow and PDO/SOI Indices up to Four Lags

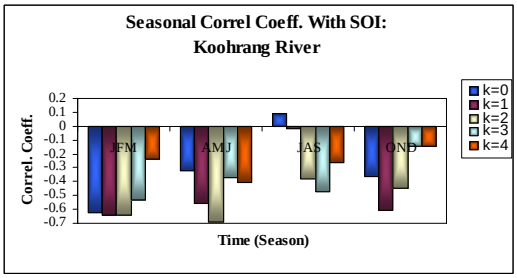












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