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Regional Hydrological Drought Monitoring Using Empirical Orthogonal Functions (EOF-SDI)

Rezgar Arabzadeh[1], Mohammad Mehdi Kholoosi[2], Javad Bazrafshan[3]
Department of Irrigation and Reclamation Engineering, University of Tehran, Karaj, Iran

rezgararabzadeh@ut.ac.ir

Abstract

Having Drought quantification is a decision-making approach for water resources planners and managers. Calculating a drought index in the measured grid-points of a given region is as the pre-requisite for regionalization process of drought by these methods. The aim of this study is the regional analysis of the streamflow drought using the multivariate technique of principal components analysis (PCA). To this end, the streamflow drought Index (SDI) was calculated in the seven hydrometric stations of Sefid-Rud basin, Iran for the period 1984-2013 in different time scale using PCA technique summarizing the SDI series of all stations into a new series so called the Multivariate Streamflow Drought Index (MSDI). Results showed a relatively high correlations between the SDI series of the stations for a given time scales. MSDI's series at multiple time scales follow all stations SDI fluctuations and appropriately monitor droughts occurred in the region especially in long dry periods.

Keywords: Hydrological Drought, PCA, Streamflow, Regional Analysis, Iran.

1. INTRODUCTION

Iran is one of the few areas that suffered from worst droughts over the last century. Drought environmental and socioeconomic bad effects are the only inheritance for Iran [1]. Also some studies that has been done recently show both duration and frequency ascension in drought index in this region [2].

Drought is a natural hazard that results from a precipitation deficiency from expected rainfall, which is inadequate to supply the demands of human activities and environment. This precipitation deficit may arise quickly over a period of time, or it may take months even years before the deficiency begins to appear in reduced stream flows and reservoir levels. Drought causes chronically inequality and Transitory balances in basin hydrology [3]. In another point of view Gumbel [4] has another definition for drought, which says drought is the smallest streamflow in yearly annual time series. Some researchers say drought is an abnormal phenomenon with complex process which is related to a specific climate region and local energy and water balance status [5].

Drought quantifying is a managerial approach for water resources planner and managers. Real time drought information acquisition containing initial time of drought and spatio-temporal diffusion are the most decisive parameters for lowering drought damages and assuring success of preparedness and mitigation [6]. Streamflow decreasing is the major effect of drought on hydro-environment system [7]. Drought effect has a large area of influencing in hydrology of basin, including groundwater stability and water quality level except surface water trend and precipitation condition [8]. Usually a drought index is a prime for assessing the effect of drought and defining different parameters including intensity, duration, severity and spatial extent. A drought variable must be able to quantify drought in variety scales of time.

Although drought indices almost are related to large scale climate indices and most of researches in this context have been focused on the national or regional scales, due to non-homogeneity in climate variation study on macro scale and local drought monitoring is also applicable [9]. A number of different indices have been developed for quantifying drought; each one has its own strength and weakness. In the following paragraph some of them are talked briefly. The Standardized Precipitation Index (SPI) was introduced by McKee et al. [10]. SPI is applicable for different region and is based on long term rainfall data records. SWSI or Surface Water Supply Index, monitors abnormalities in surface water supply sources such as stream flow, reservoirs, snow pack stored in mountainous regions and precipitation [11]. Alike to SWSI,