Seasonal DischargeTrends Analysis inSan Diego River Catchment

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ABSTRACT

San Diego River is one of the important rivers in San Diego County, California, America. In this study, seasonal volume discharge trend analysis is performedover San Diego River by z-scores and simple regression analysis from 1983-2013 for Fashion Valley Station, San Diego County, California, America. Study revealed that discharge volume in all seasons showed decrease trend except autumn (Oct-Dec) where a slope of 0.45 is observed but this increase may not be enough to compensate overall decrease in the catchment at Fashion Valley station further findings revealed that decreasing trend in winter (Jan-Mar) is greater than the other seasons with slope of -0.74 and only one wet year is observed from 1999 to 2013 in winter (Jan-Mar). Overall San Diego River Catchment observed 13 dry years out of 31 years analysis. Several causes may be associated with this decline and decrease in water quality such as urbanization related to catchment and global warming.

INTRODUCTION

The San Diego River (SDR) originates from a valley located near the towns of Julian and Santa ysabelafter the journey of 52 miles through San Diego County it reaches to its mouth in Pacific Ocean at Ocean Beach, this river located in the southern California county of San Diego. SDR was used for multipurpose through its course in southern California. The San Diego region is generally hold san arid climate. San Diego County experiences 18 degrees centigrade monthly mean temperatures. Rainfall is highly variable averaging 390 mm per annum in the region but it receives its most of the rain from autumn (October- November) to winter (January to March) and snow falls in winter (JFM). Due to increasing socio-economic activities and urbanization in the region the quality of river’s water and broadness of its channels decreasing but need of water supply in the region is increasing [1]. Floods in San Diego River Catchment (SDRC) are common as variable rainfall with variable intensity and quantity. 10 major floods (1916 to 1995) occurred in the SDRC in the 20th century [2]. Global warming is another issue, it is investigated that the sea level rise is observed approximately one inch per decade in San Diego County over the last century [3]. The discharge trend of the SDR is strongly associated with Pacific decadal oscillation [4]. The main aim of this article is to investigate the seasonal trends in discharge volume of San Diego River Catchment at Fashion Valley Station, California, USA from the available data (1983 to 2013).

2. Data and Method:

Analysis is performed for the period 1980-2013. Monthly mean discharge (ft³/s) observation data (1983-2013), for the San Diego River Catchment (SDRC) is obtained from the station (11023000, Fashion Valley California San Diego County, hydrologic Unit Code 18070304, 32°45'54"S, 117°10'04"E "NAD27, California) this station covers an area of 429 square miles. Monthly discharge data (ft³/s) transformed in representative index for winter (Jan-Mar) discharge (ft³/s) by averaging the discharge (ft³/s) from January to March and in the same way, spring (April-June), summer (July-September) and autumn (October-December) are constructed. These discharge (ft³/s) indices are the representatives for the SDRC seasonal discharge (ft³/s) then these indices are plotted against time (1983-2014) to investigate seasonal discharge trends for the available data (1983-2013) for Fashion Valley Station. This article investigates only the seasonal trends in seasonal discharge (ft³/s) of SDRC for Fashion Valley discharge station by using standardized technique. The methodology is defined as,
each yeardischarge value in a season is defined as dry (D) or wet (W) or normal (N), using standardized seasonal discharge data as follows:

\[ Z = \frac{k_j - \bar{k}}{\sigma} \]  

Where, each \( k_j \) is the seasonal discharge in the year \( j \), \( \bar{k} \) is the average seasonal discharge and \( \sigma \) is the monthly standard deviation.

Wet (W) when \( 0.5 < Z \)
Normal (N) when \(-0.5 < Z \leq 0.5 \)
Dry (D) when \( Z \leq -0.5 \)

The methodology, defined above, is also used by [5]. A year is considered as dry (wet) if at least two of the seasons experienced a condition(s) of dry (wet) out of the four seasons under study. This methodology is very simple and useful to investigate trends in discharge of a river.

Fig. 1: shows San Diego River Catchment (SDRC) California, America.

Fig. 2: shows discharge volume for the winter (Jan-March) against time (1983-2013).

Fig. 3: shows discharge volume for the spring (Apr-Jun) against time (1983-2013).
RESULTS AND DISCUSSION

Seasonal Analysis shows discharge at Fashion Valley station decreased in all seasons of SDRC except autumn (OND). Winter (JFM) and autumn (OND) are the seasons where SDRC receives its most of the precipitation while the summer (JAS) receives less rain than other seasons and hence discharge volume varies season to season (Fig. 6) in the catchment. It is noticed that the most precipitation bearing season the winter (JFM) shows declining trend in its discharge (Fig. 3) with slope -7.4 (1983-2013) while autumn (OND) discharge trend is increasing with slope of 0.45 (Fig. 5) but this increase may not enough to compensate the overall decrease in other seasons. Spring (Apr-Jun) is the second season which is experiencing decreasing trend after winter (JFM) with slope -2.4 (Fig. 3). On the basis of methodology, defined above, shows that SDRC experienced 13 dry years out of 31 years (1983-2013) and only one wet year is observed in winter (JFM) from 1999 to 2013 (Table 1).

Conclusion:

Results suggested that winter (JFM) and spring (AMJ) are two consecutive seasons (Fig. 2 and 3) where most of the declining trend occurred (1983-2013). Summer (JAS) is known as dry season as less rain received in the region hence declining trend in summer (JAS) discharge with the slope of -0.21 is observed (Fig. 4). Decline in the discharge volume for SDRC may be due to the 13 dry years observed in the catchment out of 31 years (1983-2013) and the declined trend in winter (JFM) may be associated with the decrease in the frequency of wet (only one year) years from 1999 to 2013 (Table 1) beside these, several other causes may be associated with this decline such as the increase in socio-economic activities or urbanization related to SDRC and the global
warming. Water supply authorities should noticed this severe declining trend in rain dominating season and take some suitable steps to save pure water through SDRC for the future purposes for California, America.

Table 1: shows comparison among Wet (W), Normal (N) and Dry (D) seasonal conditions with years (1983-2013). Dry years and dry seasonal conditions are showed in bold face.

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