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RAPID IDENTIFICATION OF CLIMATE CHANGE IMPACTS ON THE WEST TARUM CHANNEL

Abstrak

Fenomena El Niño dan La Niña, yang ditandai oleh anomali suhu permukaan laut (SPL) di wilayah ekuator Samudra Pasifik, memiliki dampak signifikan terhadap iklim global dan regional. Anomali SPL ini diukur menggunakan Oceanic Niño Index (ONI) yang diperoleh dari citra satelit NOAA. El Niño ditandai oleh peningkatan suhu permukaan laut lebih dari 0,5°C di atas suhu normal, sedangkan La Niña ditandai oleh penurunan suhu permukaan laut lebih dari 0,5°C di bawah suhu normal. Berdasarkan kekuatan anomali, fenomena ini dikategorikan sebagai lemah, sedang, kuat, atau sangat kuat. Peristiwa El Niño dan La Niña dapat menyebabkan berbagai bencana hidrometeorologi, yang berdampak langsung pada curah hujan dan ketersediaan air. Benua Maritim Indonesia, yang terletak di antara lautan, sangat rentan terhadap dampak kedua fenomena ini. El Niño seringkali menyebabkan kekeringan, sementara ONI positif dapat meningkatkan intensitas curah hujan. Perubahan pola cuaca global akibat fenomena ini berpotensi menurunkan curah hujan, mengganggu pasokan ketersediaan air, dan memperburuk kekeringan. Penelitian ini bertujuan untuk mengidentifikasi dampak kejadian El Niño terhadap curah hujan dan ketersediaan air di Saluran Tarum Barat, yang mencakup Kabupaten Karawang, Bekasi, dan sebagian Kota Jakarta. Dengan memahami mekanisme dampak ini, diharapkan dapat dikembangkan strategi adaptasi yang efektif. Studi literatur akan digunakan untuk menganalisis data dari penelitian terdahulu guna memberikan gambaran komprehensif mengenai curah hujan dan ketersediaan air di era perubahan iklim.
Kata Kunci: El Niño, La Niña, Oceanic Niño Index (ONI), Suhu Permukaan Laut (SPL), Ketersediaan Air.

Abstract

There is no doubt that El Niño and La Niña phenomena, which are characterized by sea surface temperature (SST) anomalies in the equatorial Pacific Ocean, have significant impacts on global and regional climate. The Oceanic Niño Index (ONI), obtained from NOAA satellite imagery, is used to measure these SST anomalies. El Niño is characterized by an increase in sea surface temperature of more than 0.5°C above normal, while La Niña is characterized by a decrease in sea surface temperature of more than 0.5°C below normal. The strength of the anomaly determines whether the phenomenon is weak, moderate, strong, or very strong. El Niño and La Niña events cause various hydrometeorological disasters that directly impact rainfall and water availability. The Indonesian Maritime Continent, located between oceans, is particularly vulnerable to the impacts of these two phenomena. El Niño causes drought, while a positive ONI increases the intensity of rainfall. These phenomena have the potential to reduce rainfall, disrupt

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water supply, and exacerbate droughts by changing global weather patterns. This study will identify the impacts of El Niño events on rainfall and water availability in the West Tarum Canal, which covers Karawang, Bekasi, and parts of Jakarta. By understanding these impacts, we can develop effective adaptation strategies. A literature review will provide a comprehensive picture of rainfall and water availability in the era of climate change by analyzing data from previous studies.
Keywords: El Niño, La Niña Oceanic Niño Index (ONI), Sea Surface Temperature (SST), Water Availability.

INTRODUCTION

The El Niño and La Niña phenomena are distinguished by sea surface temperature (SST) anomalies in the equatorial region of the Pacific Ocean. The SST anomalies are quantified by the Oceanic Niño Index (ONI), which is observed using satellite imagery provided by the National Oceanic and Atmospheric Administration (NOAA). Positive ONI events are typified by a reduction in sea surface temperatures in the southeastern sector of the equatorial Indian Ocean, concomitant with an increase in sea surface temperatures in the western region of the same area. This results in a westward shift of convective clouds from the eastern Indian Ocean warm pool. In contrast, a negative ONI is indicative of an increase in sea surface temperature (SST) in the southeastern region of the equatorial Indian Ocean and a corresponding decrease in SST in the western region of the Indian Ocean. This results in a strengthening of convective clouds within the region. (National Centers for Environmental Information, 2021).

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The El Niño phenomenon is defined by an increase in sea surface temperature (SST) of more than0.5°C above the normal range, whereas La Niña is characterised by a decrease in SST of more

than 0.5°C below the normal range. Based on the temperature anomaly values, the strength of El Niño and La Niña can be categorized as follows: very strong, strong, moderate, and weak. Anomalies in the 0.5-1°C range are classified as weak, those in the 1-1.5°C range as moderate, those in the 1.5-2°C range as strong, and those in excess of 2°C as very strong. (National Centersfor Environmental Information, 2021; Cai W et al., 2014; Supari et al., 2018).

The occurrence of El Niño and La Niña events has the potential to impact climate patterns at bothregional and global scales, which can subsequently result in the emergence of a range of hydrometeorological disasters. Indonesia's maritime position between oceans renders it particularly susceptible to El Niño events and the Oceanic Niño Index (ONI) phenomenon. El Niño events have been linked to droughts in Indonesia (Davey, 2011; WMO, 2014). Conversely, positive ONI events have been observed to result in an increase in rainfall intensity in Indonesia (Nabilah et al., 2017).

A reduction in precipitation resulting from alterations in global weather patterns has a detrimental impact on water availability, leading to disruptions in the water supply and the exacerbation of drought conditions (Supari et al., 2018; Khedun et al., 2012; Hendon, 2003). Impactof El Niño prompts surface water users to reassess the availability of water supplies, with the objective of evaluating the efficacy of meeting demand and determining water allocation policies in water resources management (Power et al., 2013; Thomson et al., 2003; Hendon H., 2003; Utami et al., 2021).

The research site is situated in the West Tarum Canal, which is located downstream of the Jatiluhur Reservoir and Curug Weir, which are situated within the boundaries of Purwakarta

Regency. The West Tarum Channel flows in an eastward direction, traversing the territories of Karawang Regency and Bekasi Regency. The West Tarum Canal ultimately discharges into the western region of Jakarta City, where it facilitates the delivery of water to agricultural and residential areas along its course.

METHODS

The research site is situated in the West Tarum Canal, which is located downstream of the Jatiluhur Reservoir and Curug Weir, which are situated within the boundaries of Purwakarta Regency. The West Tarum Channel flows in an eastward direction, traversing the territories of Karawang Regency and Bekasi Regency. The West Tarum Canal ultimately discharges into the western region of Jakarta City, where it facilitates the delivery of water to agricultural and residential areas along its course.

Figure 1 Study Location

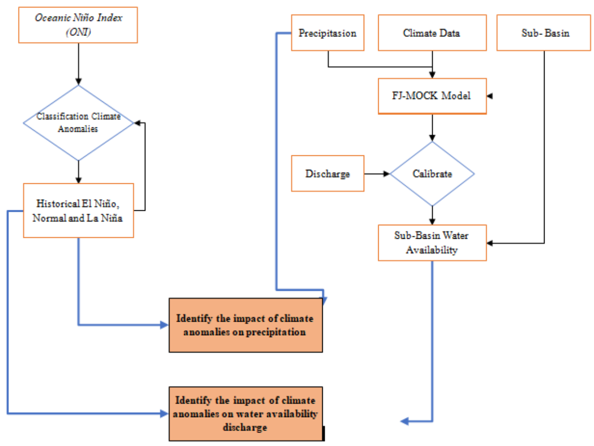


Figure 2 Research Framework

Figure 2 Research Framework

Data

Table 1 Data Requirements

No	Data	Vendor	Data Source
1	Ocean nino Index (ONI) in 2009-2020	NOAA	http://www.nws.noaa.gov/
2	Daily Rainfall of 12 Groundstation Rainfall Posts 2009 -2020	Perum Jasa Tirta II	https://www.jasatirta2.co.id/

3	Daily Climatology Year 2009 -2020	Badan Meteorologi, Klimatologi & Geofisika (BMKG)	https://dataonline.bmkg.go.id/home

Table 2 Category of Climate Anomaly Determination

Anomali	**Kategori**
>2˚ C	El-Nino very strong
1,5˚C s.d 2˚C	El-Nino strong
1˚C s.d 1,5 ˚C	El-Nino Moderate
0,5 ˚C s.d 1 ˚C	El-Nino Weak
-0,5 ˚C s.d 0,5 ˚C	Normal
-0,5 ˚C s.d -1 ˚C	La-Nina Weak
-1˚C s.d -1,5 ˚C	La-Nina Moderate
-1,5˚C s.d -2˚C	La-Nina strong
> -2˚ C	La-Nina very strong

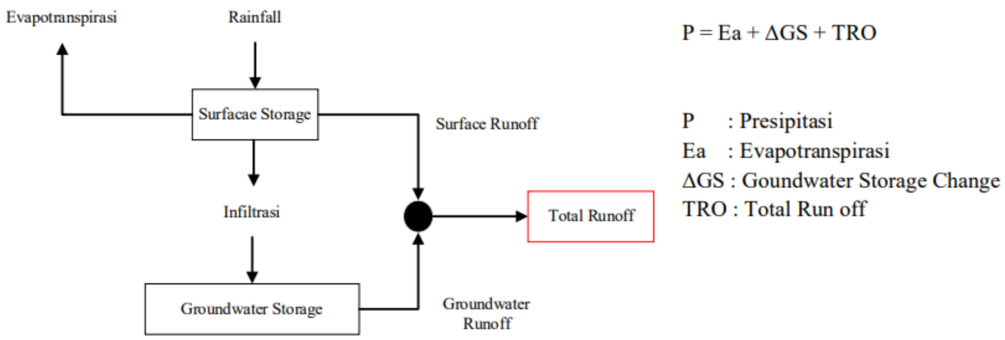
Sumber : National Centers for Environmental Information, 2021

Precipitation

This study employs a method for identifying Impactof climate change based on daily rainfall data at 12 station, which is then accumulated into monthly data. This data is then compared with the occurrence of climate anomalies in the period between 2009 and 2020. Subsequently, the rainfall anomalies were subjected to graphical representation, thereby facilitating a visual comparison between the rainfall patterns under normal, El Niño, and La Niña climatic conditions.

Water Availability

A water availability analysis utilising the F.J. Mock method. In 1973, Dr. F.J. Mock introduced a simple model of monthly water balance simulation for streams that included rainfall data, evaporation, and the hydrological characteristics of the drainage area. In analyzing the water availability discharge in the F.J. Mock model, it is necessary to determine in advance the post-estimated water (PDA) value to be calibrated. Calibration is achieved through the adjustment of coefficient values and the establishment of a specified error value, which then serves as the error limit for determining the coefficient. The F.J. Mock coefficient, obtained through calibration, is then applied to each sub-watershed. (Setiadi et al., 2022; Subrata et al., 2020)



RESULT AND DISCUSSION

The ENSO phenomenon is defined as a condition in which Sea Surface Temperature (SST) anomalies are +0.5°C or greater (indicative of El Niño) or -0.5°C or less (indicative of La

Niña) for three consecutive months. This study analyzes climate anomaly conditions from 2009 to 2020 using NOAA's Ocean Niño Index (ONI). The ONI data are processed into a graph and categorized based on the type of climate anomaly.A graph based on the ONI from 1995 to 2020 shows a significant trend of climate change. During this period, there have been fluctuations that reflect extreme weather events such as El Niño and La Niña.

Three positive ONI (El Niño) anomalies were observed between 2009 and 2020, with categories ranging from weak to very strong. The longest El Niño period lasted 19 months, from September 2014 to May 2016, with a maximum ONI value of 2.6 at the peak of the event in October, November and December 2015 (Figure 1). A weak El Niño was observed from August 2018 to July 2019. In contrast, negative ONI anomalies (La Niña) have been observed five times, with categories ranging from weak to strong. The longest La Niña period was from March 2010 to

March 2011, with a duration of 25 months. The maximum negative ONI value of -1.6 was recorded at the peak of the event, which lasted from August to January (Figure 1). The weak category La Niña occurred from June 2016 to December 2016.

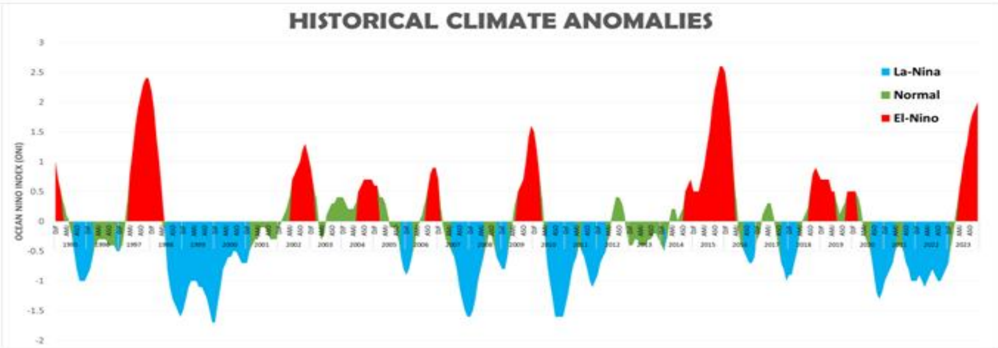


Figure 3 Historis Anomali Climate

Identify the impact of climate anomalies on precipitation

The effect of climate anomalies on rainfall was analyzed by comparing historical climate event data with monthly rainfall recorded at 12 stations in the West Tarum Canal area. Prior to the comparative analysis, the rainfall data from the ground stations were tested for suitability using several statistical tests, including outlier test, trend test, stability test, and independence test. The results of the suitability test showed that the rainfall data from the 12 stations met the established criteria and were suitable for use in this study.

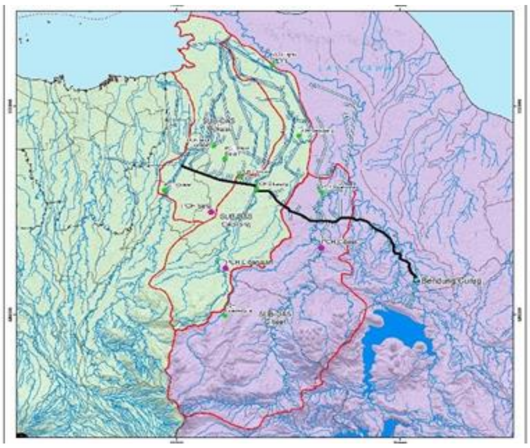


Figure 4 Historis Anomali Climate

A total of 12 rainfall stations were analyzed, with three selected for further investigation in this study. The objective of the comparative analysis of climate anomaly occurrence data from these three stations is to identify and analyze Impactof climate anomalies on rainfall patterns in the West Tarum Canal.

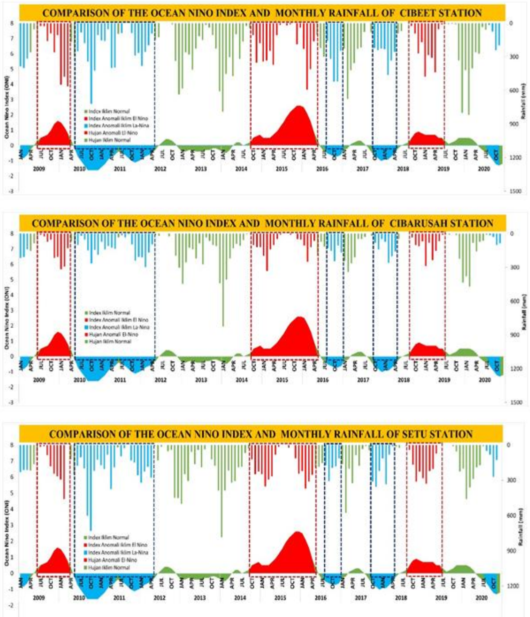


Figure 5 Historis Anomali Climate

Based on the climate anomaly identification plots of the three rainfall stations for the period 2009- 2020, it was found that the very strong El Niño climate anomaly in 2015 had a significant impact on rainfall. The data show that during the peak of El Niño, which lasted from June 2015 to January 2016, positive ONI values reached very high levels, reflecting extreme El Niño conditions. This effect was evident in the reduction of rainfall in the region, with average monthly rainfall hovering just below 50 mm, well below normal levels. The graph below illustrates the strong correlation between the peak ONI values and the low rainfall during this period, confirming the tremendous impact of El Niño on local rainfall patterns. In addition, the BMKG also classified 2015 as a dry season, reinforcing the finding that El Niño conditions strongly influenced the climate and rainfall in the West Tarum Canal.

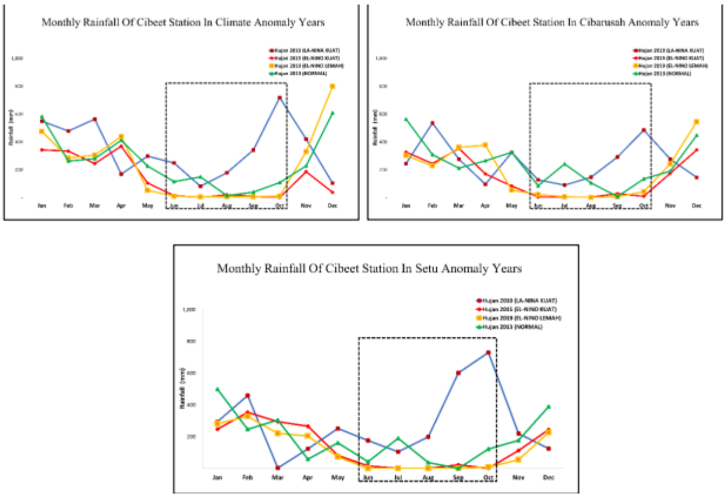


Figure 6 Monthly Rainfall Of Cibeet Station In Climate Anomaly Years

The El Niño climate conditions identified in 2015, which were classified as very strong, as well as a weak El Niño in 2019, show that rainfall was significantly lower during these periods compared to normal and La Niña climate conditions. Precipitation data from both years show that climate anomalies had a major impact on the reduction in precipitation, with intensities well below average. In 2015, a very strong El Niño led to a drastic reduction in rainfall, while in 2019, despite a weak El Niño, the impact on rainfall was still significant, with lower rainfall compared to normal conditions. Both years were identified as periods of very large climate anomalies that drastically affected rainfall patterns in the region.

Identify the impact of climate anomalies on water availability runoff

The discharge calculation in this analysis uses the FJ Mock method, which is then calibrated with data from the water stations in each sub-watershed. The identified discharge is the result of three sub-basins that contribute to the inflow in the West Tarum Canal, namely Cibeet Sub-basin (Cibeet Rain Post), Cikarang Sub-basin (Cibarusah Rain Post), and Bekasi Sub-basin (Setu Rain Post). Discharge is analyzed based on regional rainfall, which includes data from the three rain stations that have been identified as influenced by climate anomalies. The identification of Impactof climate anomalies based on the climate year of occurrence, namely the La Nina climate anomaly in 2010, the El Nino climate anomaly in 2015, and the normal climate in 2013, can be seen in Figure 7-9. This approach ensures that the runoff and precipitation analyses are synchronized, supporting the main objective of identifying the impact of climate anomalies on precipitation and runoff.

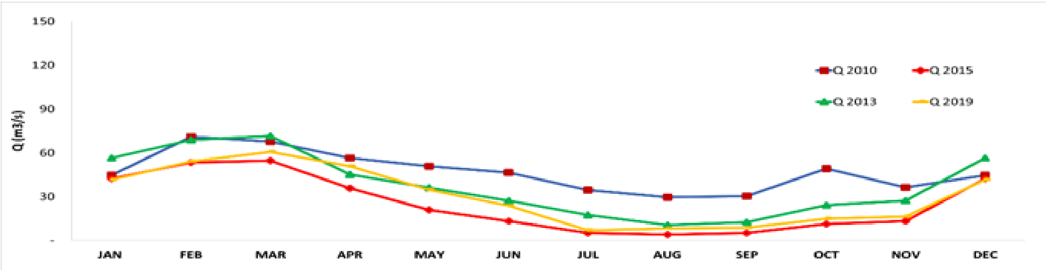


Figure 7 Monthly Discharge During Climate Anomalies Station Cibeet (sub-basin Cibeet)

The discharge of the Cibeet subwatershed under La Niña climate conditions in 2010 from April to November was higher than under normal and El Niño climate conditions. This indicates that precipitation during this period was higher than in normal and El Niño years. Conversely, in years with El Niño conditions, runoff decreased significantly from July to October. When correlated with rainfall data, it was found that rainfall in these months was lower than in other months. From the analysis of the discharge and unit rain hydrographs, a consistent pattern was found between rainfall and the resulting potential discharge, where in 2015 there was a uniform decrease in rainfall and potential discharge.

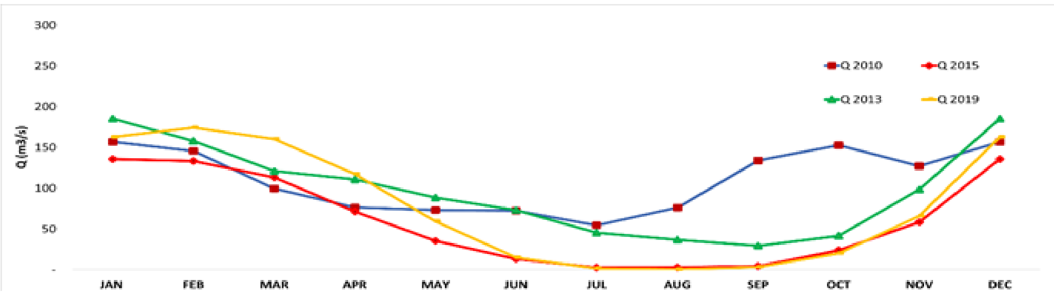


Figure 8 Monthly Discharge During Climate Anomalies Station Cibarusah (sub-basin Cikarang)

The discharge of the Cikarang sub-watershed during the La-Nina climate conditions in 2010, from January to July, was lower than under normal climate conditions. This shows that during this period there was still an influence from the El Niño phenomenon in 2009, which caused the rainfall to be lower than normal conditions. In the years with the El Niño climate phenomenon, namely 2015 and 2019, there was a significant decrease in runoff from June to October. When correlated with precipitation data, precipitation in these months was also lower than in other months. From the analysis of discharge and rainfall unit hydrographs, a consistent pattern between rainfall and potential discharge was obtained. In 2015 and 2019, there was a consistent decrease in both rainfall and potential discharge.

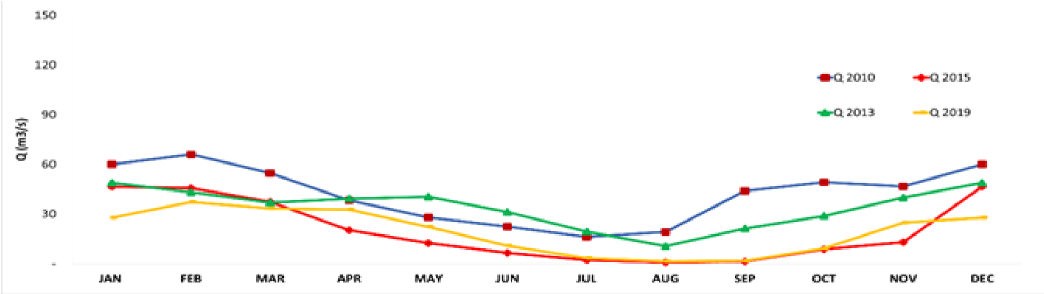


Figure 9 Monthly Discharge During Climate Anomalies Station Setu (sub-basin Bekasi)

The discharge of the Bekasi sub-basin decreased significantly in the years with the El Niño climate phenomenon, namely in 2015 and 2019, especially from June to October. When correlated with rainfall data, it can be seen that rainfall in these months is also lower compared to other months. From the analysis of runoff and unit rain hydrographs, a consistent pattern was found between rainfall and potential runoff generated. In 2015 and 2019, there was a uniform decrease in both rainfall and potential discharge.

Identification of Impactof climate anomalies on sub-basin discharge showed strong evidence, as shown by the validated graphs for each sub-basin. The graphs confirm that the El Niño climate anomalies in 2015 and 2019 had a significant impact on reducing discharge. This decrease in runoff occurred consistently over the same time period, between June and October. This shows how strong Impactof El Niño is on the pattern of water discharge in the western Tarum channel area.

CONCLUSIONS

The very strong El Niño in 2015 led to a drastic reduction in rainfall, with average monthly rainfall well below normal. Although El Niño was relatively weak in 2019, its impact was still significant in reducing rainfall compared to normal and La Niña conditions. The El Niño climate anomaly significantly reduced runoff in the sub-basins that drain into the West Tarum Canal, particularly from June through October. In contrast, La Niña conditions increased runoff compared to normal and El Niño conditions. Overall, El Niño climate anomalies, both strong and weak, were shown to strongly influence rainfall patterns in the region, resulting in significantly below-average rainfall and discharge from June to October.

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