The Impact of Positive IOD and El Niño on Rainfall, Groundwater Level, and Soil Moisture in Peatlands in OKI Regency

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Abstract. Peatlands in OKI regency often burned massively during the extreme dry season. In 2023 an extreme dry season occurred due to the natural phenomena IOD+ and El Niño simultaneously. These two phenomena can impact the dynamics of hydro-climatological parameters in peatlands. This research aims to analyze the impact of these two phenomena on the parameters of rainfall (RF), groundwater level (GWL), and soil moisture (SM) on peatlands in OKI regency. The data used is data for the 2023 dry season originating from the Tanjung Serang OKI measuring station. Data analysis was carried out graphically and used linear regression analysis. The results of this research show that from July to November (JASON), the values of RF, GWL, and SM parameters fell sharply. It was also found that RF greatly influenced GWL. Then it was also found that in JASON 2023 the correlation between GWL and SM was quite strong. The correlation between these two parameters is SM = 30,172 GWL + 70,119.

Keywords: ENSO, IOD, Dry season.

1 Introduction

Indonesia has tropical peatlands covering an area of 1.73 million hectares. These peatlands are spread across several islands, including the island of Sumatra. On the island of Sumatra, the province that has the largest peatland is the province of South Sumatra. Peatlands in South Sumatra province are also spread across several districts [1], [2]. The district that has the largest peatland in South Sumatra province is Ogan Komering Ilir (OKI) Regency [3], [4].

During the dry season, peatlands in OKI Regency are very flammable because the peat surface is very dry. Apart from that, several irresponsible human activities trigger

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the emergence of fires on peatlands [5], [6]. In 2023 there will be an extreme dry season caused by a combination of the natural phenomena El Niño and positive IOD. This phenomenon results in very minimal rainfall so that peatlands become dry and prone to burning.

Fire incidents in peatlands in Indonesia often occur, especially during the El Niño, IOD+, and a combination of these two phenomena. To mitigate the fire disaster, the Indonesian government has installed several measurement stations for three main climate parameters that are closely related to fires on peatlands, namely: rainfall, groundwater level and soil moisture [7], [8]. The measurement station carries out measurements in situ and sends the measurement results online to the laboratory where it is then processed to become information ready for analysis. One of the stations in OKI Regency is Tanjung Serang Station. This research has used data from this station.

This research is focused on examining the dynamics of rainfall, groundwater levels and soil moisture in peatlands in OKI Regency during the 2023 dry season. This research is very interesting because in 2023 there was a combination of El Niño and IOD+ phenomena, causing drought and fires very massive in peatlands in OKI Regency. Previous research was conducted in OKI Regency on the dynamics of these three parameters but used data before 2023 and at different stations [5], [9], [10]. It is hoped that this research can complement previous research so that it becomes a more comprehensive input for mitigating fires on peatlands, especially in OKI Regency.

2 Methodology

This research was conducted in OKI Regency, South Sumatra Province, Indonesia. Data measurements were carried out at Tanjung Serang Station with coordinates (104.911705, -3.447086). This station is located on peat land which often experiences fires during the extreme dry season. This station is capable of measuring hourly data for rainfall, groundwater level and soil moisture in situ. The data used in this research is data for the dry season in Indonesia, namely for the period 1 July 2023 to 30 November 2023.

The data obtained was processed graphically to obtain time series graphs for rainfall, groundwater level and soil moisture parameters. The time series graphs that have been obtained are analyzed to determine the dynamics of these three parameters and look for their lowest values because in the extreme dry season the values of these three parameters usually drop drastically. Then a linear regression analysis was carried out to determine the relationship between rainfall and the correlation between groundwater level and soil moisture. From this analysis, an empirical equation was obtained that connects soil moisture with groundwater level.

3 Result and Discussion

This research produces time series graphs that describe the dynamics of rainfall, groundwater level and soil moisture during the dry season from July 2023 to November

2023. This research also produces graphs about the relationship between rainfall and groundwater level and the correlation between groundwater level and soil moisture.

3.1 Rainfall

The dynamics of rainfall are shown in Figure 1. In Figure 1 it appears that very minimal rainfall occurred in August 2023 until October 2023. In fact, from 26 August to 8 October (43 days) there was no rainfall at all (rainfall = 0). If we calculate the average rainfall for the period July to November (JASON) 2023, we get only 0.15 mm/month. This very minimal rainfall is because in 2023 two natural phenomena occurred at once, namely IOD+ in the Indian Ocean and El Nino in the Pacific Ocean. These two phenomena cause a lack of rainfall in most parts of Indonesia, including OKI Regency [2], [11], [12].

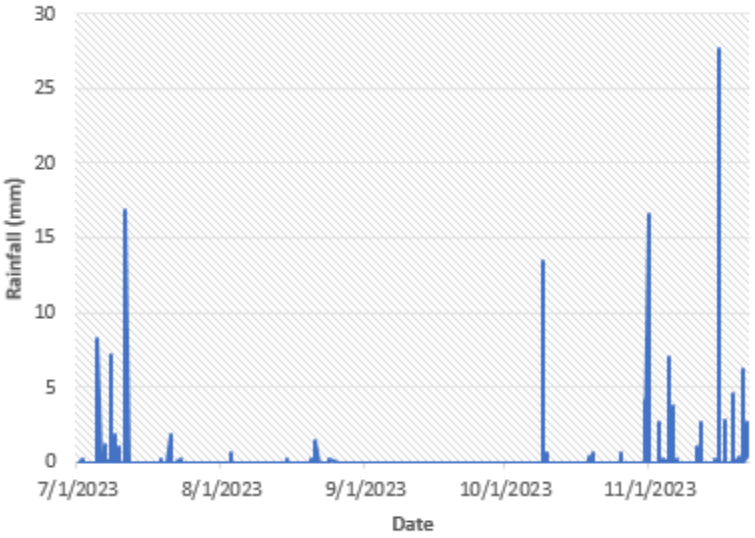

Fig. 1. Time series graph of rainfall.

3.2 Groundwater Level

The dynamics of groundwater levels in the JASON 2023 period are shown in Figure 2. In Figure 2 it appears that in the JASON 2023 period the trend of groundwater levels is decreasing. The lowest value of groundwater level achieved was -1.93 m which occurred on November 16. This value is much lower than the minimum groundwater level that must be maintained to prevent peatlands from burning, namely -0.4 m [13]. Therefore, in JASON 2023 period there were severe fires on peatlands.

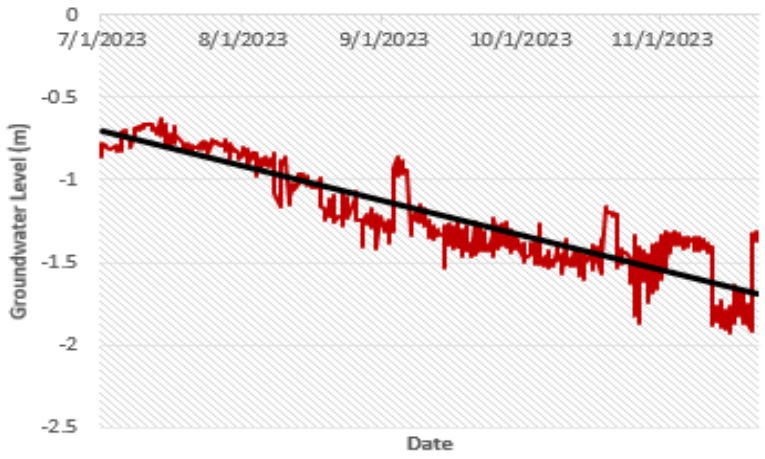

Fig. 2. Time series graph of groundwater level.

3.3 Soil Moisture

Figure 3 displays a time series graph regarding soil moisture dynamics. In the graph it appears that during the JASON 2023 period the trend of soil movement is decreasing. In JASON 2023 the lowest soil moisture was 7.87 % in November 14. The lack of rainfall causes groundwater levels to drop so that soil moisture on the peat surface also decreases so that the soil surface of the peat land becomes dry [14], [15]. This dry soil surface causes it to become flammable.

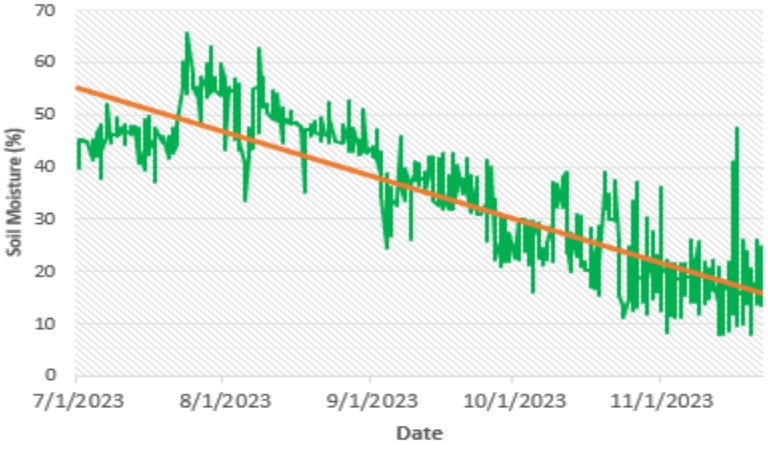

Fig. 3. Time series graph of soil moisture.

3.4 Relationship between Rainfall and Groundwater Level

Figure 4 displays a graph of the relationship between rainfall and groundwater level. From this graph it appears that rainfall has an effect on groundwater levels. If rainfall is very low for a long time, groundwater levels tend to continue to decline [15]. This can be seen in the period August to October.

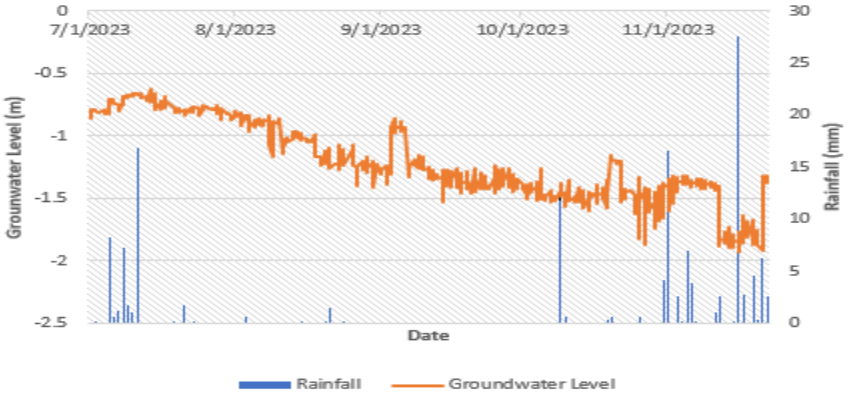

Fig. 4. Graph of relationship between rainfall and groundwater level.

3.5 Correlation between Rainfall and Groundwater Level

Figure 5 displays a correlation graph between soil moisture (SM) and groundwater level (GWL) in the JASON 2023 period. In this figure it appears that groundwater level has a fairly close relationship with soil moisture where the correlation coefficient (r) = 0.75. The empirical equation which states the correlation between these two parameters is SM = 30.172 GWL + 70.119. It can also be seen in the picture that soil moisture is influenced by the groundwater level, where the higher the groundwater level, the higher the soil moisture.

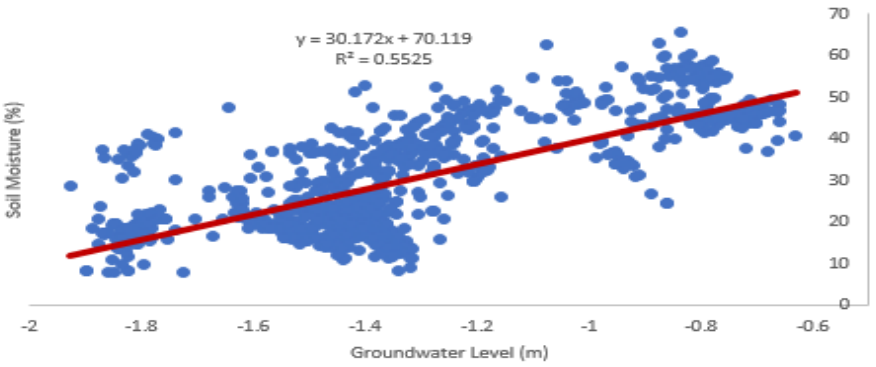

Fig. 5. Graph of correlation between soil moisture and groundwater level.

4 Conclusion

When the IOD+ and El Niño phenomenon occurred in 2023, especially in the July to November (JASON) period, the values of rainfall, groundwater level and soil moisture parameters fell sharply. It was also found that rainfall greatly influences groundwater levels. Then it was also found that in JASON 2023 the correlation between groundwater level and soil moisture was quite strong (r = 0.75). The empirical equation that states the correlation between soil moisture and groundwater level is SM = 30,172 GWL + 70,119.

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Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article

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