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Change in Rainfall Pattern due to Climate Change and Its Influence to the Tropical Peat Fire Risks

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Introduction

In recent decades, Indonesian tropical peatlands have gained attention due to frequent fires. Found mostly in lowlands, these areas are seen as having economic potential. That's why converting tropical peatland forests into agricultural lands, like oil palms and acacia plantations, was unavoidable. Unfortunately, these changes involve draining peat water through canals, making the peatlands more susceptible to the risk of fires.

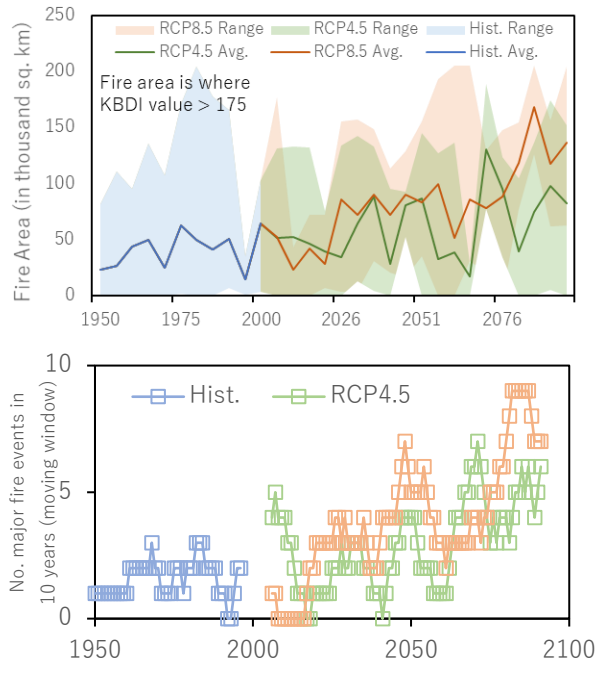

Figure 1. Area and frequency of fires increases

Our earlier research indicated that the Keetch-Byram Drought Index (KBDI) accurately reflects fire risks in tropical peatlands. By utilizing the NEX-GDDP-CMIP5 MRI CGCM datasets in KBDI, we found that the frequency and extent of high fire risks are projected to rise in tropical peatlands in the future (Figure 1). While many studies attribute the increase in wildfires to climate change, primarily driven by rising temperatures, our research suggests that changes in rainfall patterns are equally important contributors to the heightened fire risks.

Method

In this study, we employed the MRI-CGCM NEX-GDDP-CMIP5 datasets (historical, RCP 4.5, and RCP 8.5) along with the modified Keetch-Byram Drought Index (KBDI) as described by Taufik et al. (2015). Our aim was to assess the impact of future changes in rainfall patterns and increasing temperatures on fire risks.

To analyze the contribution of each variable to the risk of fire, we assumed a constant temperature within each scenario—32°C for the historical period, 33.5°C for future RCP 4.5, and 35°C for future RCP 8.5. As temperatures rise, the conditions for high fire risk can occur with a decreased number of consecutive dry days (CDD), specifically 60 days for the historical scenario, 50 days for RCP 4.5, and 45 days for RCP 8.5 (Figure 2). The study utilized these CDD thresholds to assess how the frequency of fires changes based on rainfall patterns, temperature, and their combination.

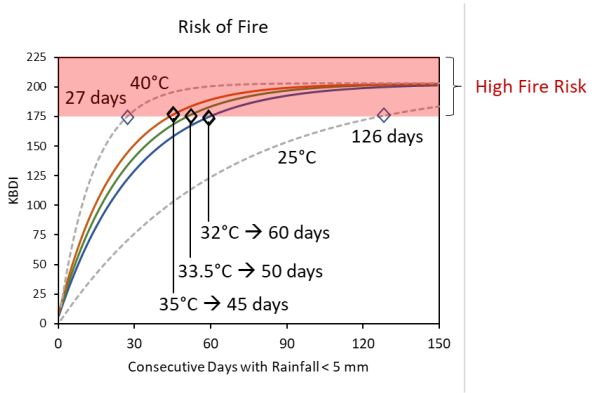

Figure 2. Shorter CDD causes fire risk at higher temperature

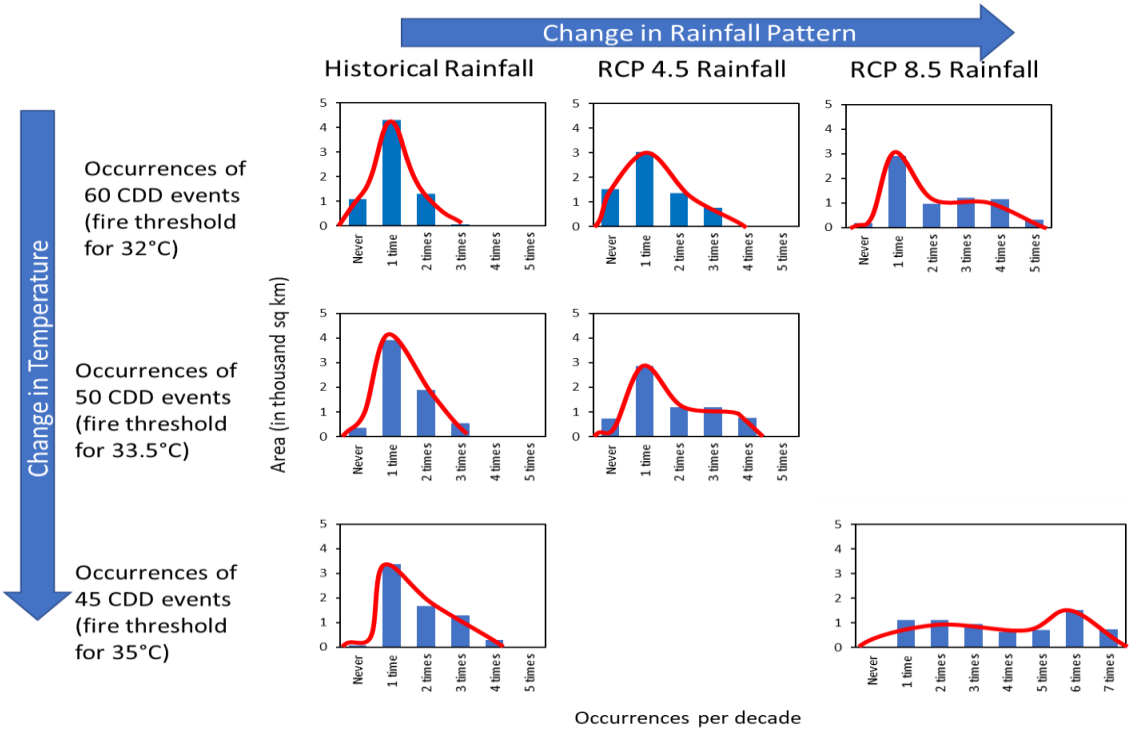

Figure 3. Impact of change in rainfall pattern and temperature to distribution of fire frequency

Results and Discussions

In the future, we expect more consecutive dry days each year, and this increase will vary more in RCP 8.5 compared to RCP 4.5.

The way dry days are distributed also changes in different scenarios, as shown in Figure 3. In the historical period, dry days are relatively short, and occurrences of days longer than 60 CDD are rare. Some areas have never experienced such long droughts. However, in future scenarios, these extended dry periods happen more often — up to 3 times in RCP 4.5 and 5 times in RCP 8.5.

As temperatures rise in the future, the conditions for high fire risk can happen with fewer consecutive dry days. For example, with a 1.5°C temperature increase (RCP 4.5), high fire risk would occur with 50 CDD instead of the historical 60 CDD. If we look at the historical rainfall pattern, fire risks might increase up to 3 times per decade, but with the RCP 4.5 rainfall pattern, fire risks could increase up to 4 times. If the temperature increases by 3°C (RCP 8.5), high fire risk can occur with 45 consecutive dry days. In the historical rainfall pattern, fire risks could still happen up to 4 times per decade. However, with the RCP 8.5 rainfall pattern, the temperature increase could raise the frequency of fires to 7 times in a decade.

Conclusions

In summary, our study indicates that, if there is no increase in daily maximum temperature (equal to historical scenario), we can expect a major fire event roughly once every decade, regardless of the concurrent rainfall pattern. However, with the future rainfall patterns, particularly RCP 8.5, there are occurrences of frequent but relatively smaller fire events in particular areas.

As temperature rises, the rainfall pattern create significant difference in distribution of fire event. The historical rainfall pattern still show one major fire event in a decade but the RCP 8.5 rainfall pattern show that some areas will be on fire every other year.

References

Taufik et al. (2015), Modification of a fire drought index for tropical wetland ecosystems by including water table depth, *Agr. and Forest Meteo.,*203,1-10pp.