Tropical Peat Fire Suppression Through Water Injection on a Laboratory Scale

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Peatland fires

Fig. 1 . World map of peatland distribution; boreal, subtropical and tropical peatland

During the drought season, peat fire spreads widely and sustain for a long period of time, i.e., weeks or months, despite rainfalls and firefighting efforts. Peat fire is difficult to suppress as it is governed by smouldering combustion, the most persistent type of combustion phenomenon.

Smouldering

Smouldering is flameless combustion with relatively low temperature compared to flaming, with peak temperature up to 500–700℃. The incomplete oxidation reaction in smouldering results in higher toxic gas emissions than flaming combustion.

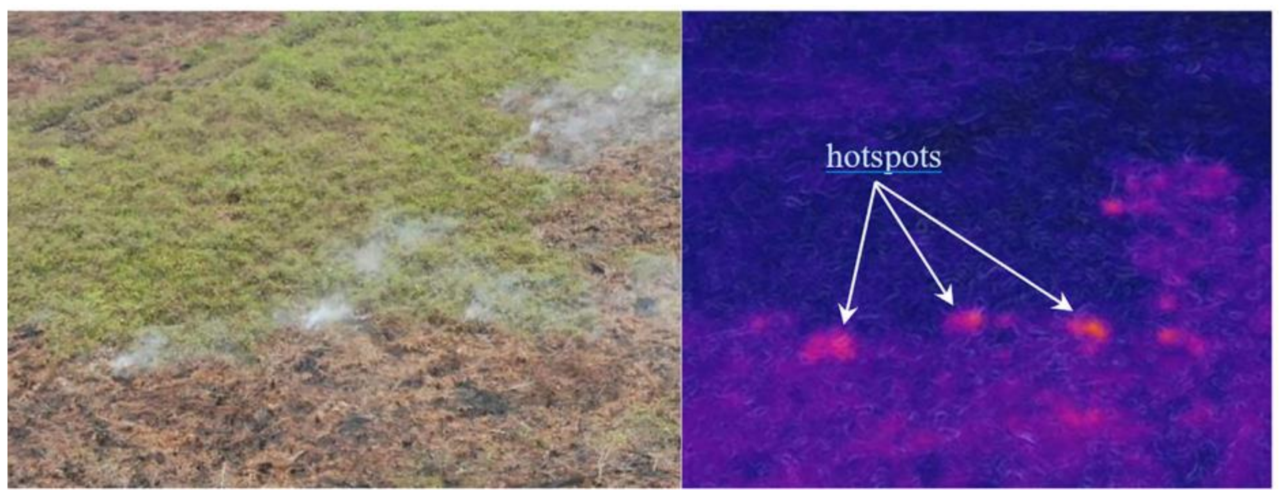

Fig. 2 . Aerial view of visual (left) and infrared (right) of an example peat fires case in Jambi, Indonesia, 2019

Peat fires Impacts

Environment Health Economy

Suppression Mechanism

This study reports laboratory experiments of peat fire suppression by means of water injection directly to the subsurface hotspot of natural peat samples from Papua and Jambi, Indonesia (Fig.3). Thermocouples and IR camera was used to capture the temperature of the smouldering process. It was continuously recorded until below 50℃ to ensure no potential occurrence of reignition.

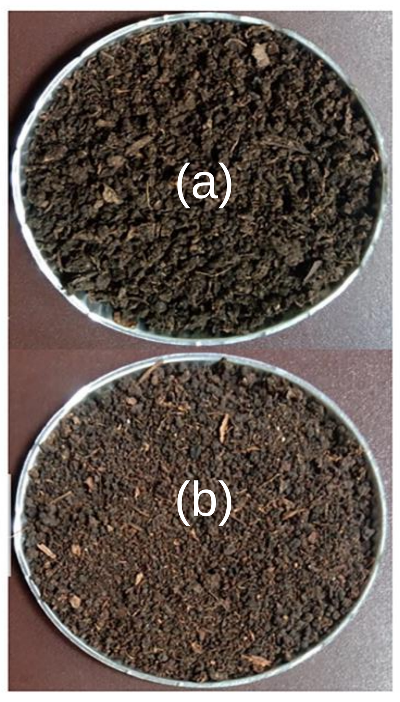

Fig. 3. Peat samples for suppression experiment (a) Papuan peat sample (b) Jambi peat sample.

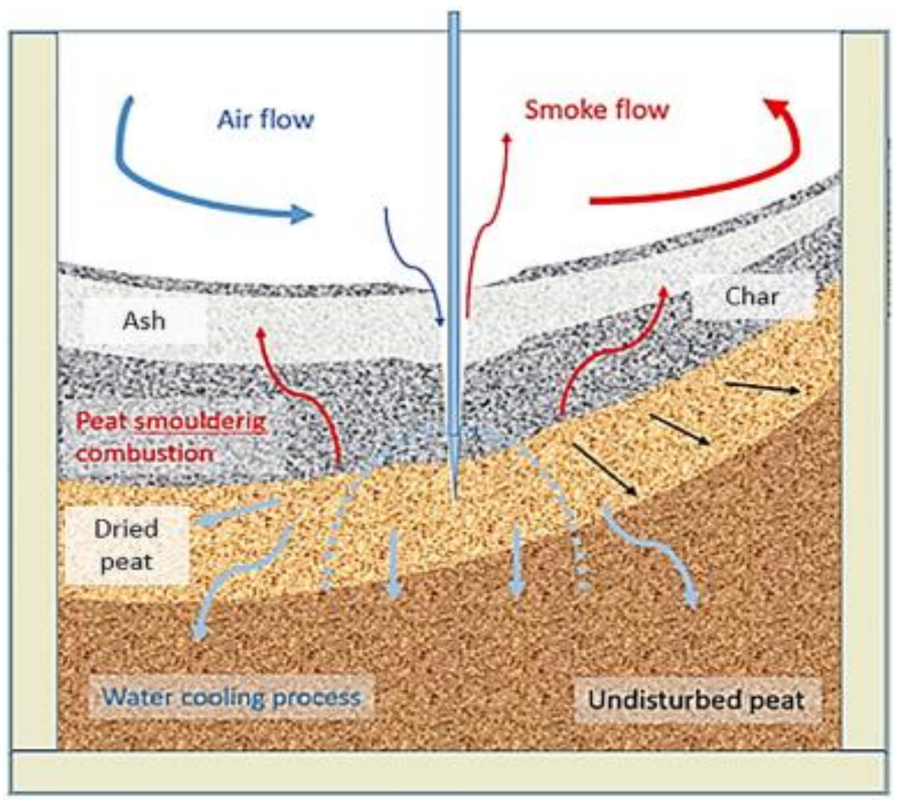

Fig. 4 . The behaviour of the peat smouldering during suppression by water-based injection

Effectiveness

V_{req}(L), was measured by subtracting the volume of water run-off (V_{rf}) of the reactor from V_{gross} (L). A mass balance was used to measure peat. Considering the initial mass of the peat sample ($m_{peat,0}$), the effective water (E_f) can be estimated as: $E_f = V_{req} / m_{peat,0}$

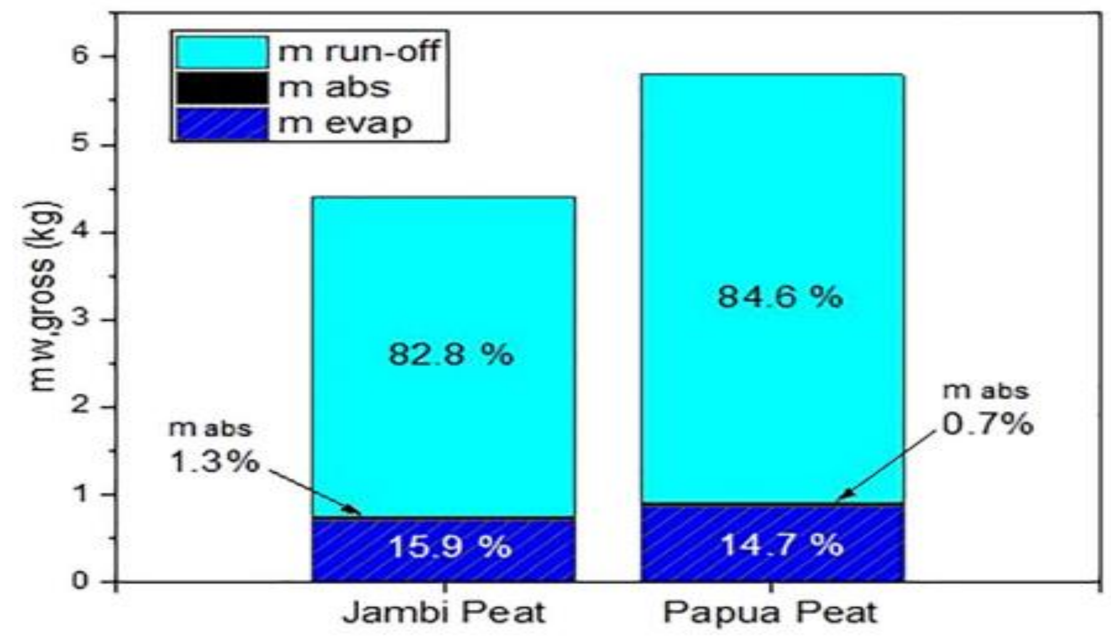

Fig. 5. The estimated mass of water evaporated from each peat sample tested.

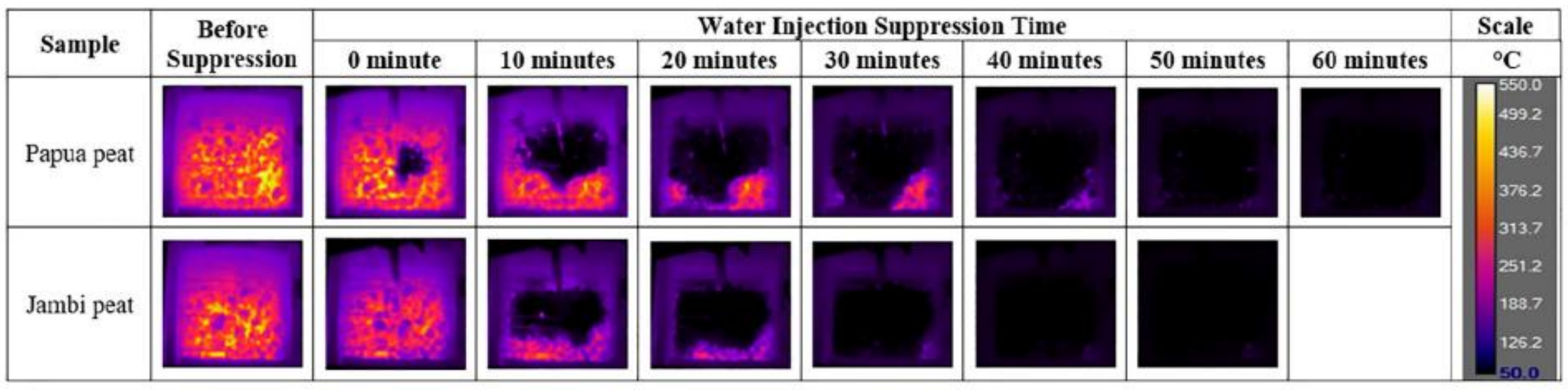

Fig. 6 . Top view of Surface Temperature Distribution of each water-based injection by Infrared Camera

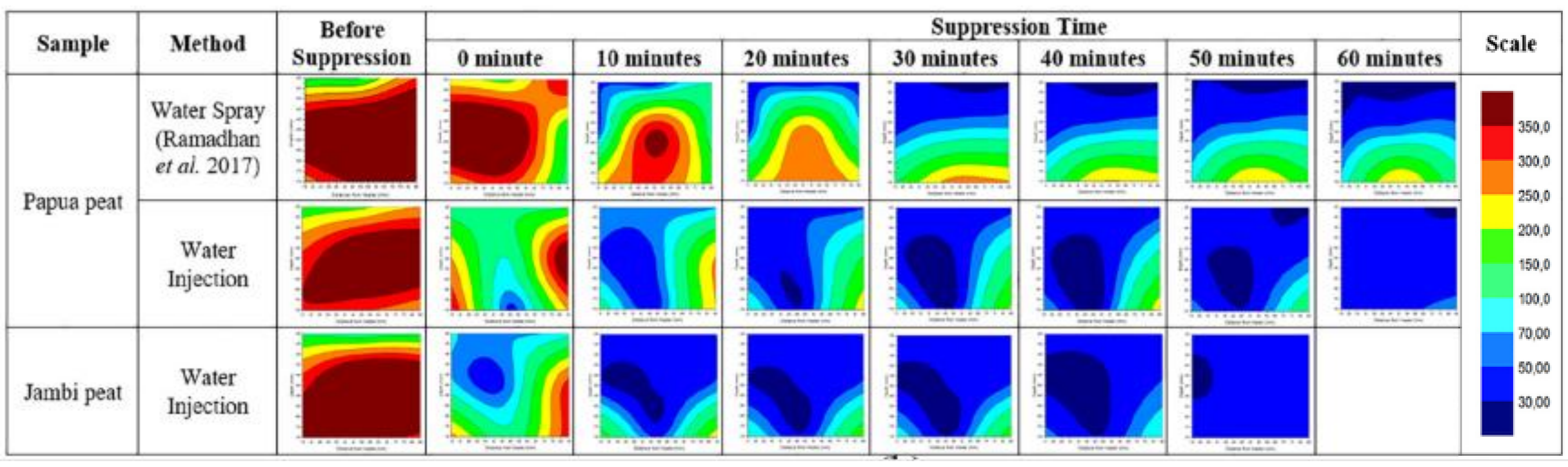

Fig. 7. Plotting temperature by thermocouple data reading. Temperature distribution of smouldering peat suppression of Papuan samples by water spray [Ramadhan et.al, 2017], and by water injection for Papuan and Jambi peats

Research Work

Objectives

To determine the efficiency of the water injection by the duration of suppression and calculate the amount of water absorbed by the peat during smouldering propagation.

"As the water resources are very limited in the peatlands area, finding suppression methods that could effectively attack the hotspot beneath the surface would benefit the firefighter operation."

Conclusions

Water injection is more efficient than the water spray technique based on suppression duration and water consumption in extinguishing hotspot areas, it is about half of the water spray. To fully suppress the fire, Papuan peat required 4.22±0.26 L of water per 1 kg of peat, while Jambi peat required 3.81±0.03 L/kg-peat. This study contributes to a better understanding of the suppression dynamic of the water injection technique and proposes its implementation for early peat fire mitigation in the field.

References:

Acknowledgement : UNIVERSITAS INDONESIA, Veritas, Probitas, Iustitia | Est. 1849; BEASISWA PMDSU; SFPE Foundation; LEVERHULME Centre for Wildfires, Environment and Society