The Response of Water Level Depth to Vegetation Composition in Degraded Peatland: a Case Study of Sriwijaya Wetland Botanical Garden, Indonesia

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Abstract. Peatland restoration requires revegetation with attention to different arrangements and planting patterns according to land cover conditions, the peat's thickness, and the water level. The study aims to assess the response of water level depth to vegetation composition in degraded peatland. The study used a prospective observational approach in real environmental situations. In the 3x3 m observation box divided into four quadrants, five monitoring wells were made using a pipe size of ¾", planted vertically at each corner point of the observation box and its center. The amount of species is counted manually and differentiated by plant growth form (tree or else). At the same time, the composition is measured by the proportion of trees in a particular quadrant. The result showed at least fourteen species identified in the observation box with the majority in the form of an understory plant. The study also found some irregular patterns of the water level changes. The study concluded that the water level is likely to respond to species’ roots systems rather than vegetation composition.

1. Introduction
Degraded peatland is not only unproductive land, but also can be a source of disasters, ranging from droughts, floods, landslides, to fires that can have an impact on the acceleration of global warming. The government has issued Government Regulation No. 71/2014 to overcome the peat ecosystem damage in Indonesia, one of which is through revegetation [1]. The revegetation needed to pay attention to different arrangements and planting patterns according to land cover conditions, the planting locations, the thickness of peat, and the land tenure status of the implanted site [2]. Because of fluctuation of water level, not all types of plants can be used to restore degraded peatlands [3].

In general, the components of the water level respond to each rainfall event where gradual changes occurred between the drain of point and intact sites. The changes including depth exceedance probability curves and seasonality of water level variability [4]. Aside from the rainfall, evaporation-transpiration process [5] and presence of the canal and floodgate also affects the fluctuation of water level depth. On the other side, previous study showed that vegetation patch size made positive effects on improving preferential flow and water movement [6]. Functional traits mechanistically capture plant responses to environmental gradients as well as plant effects on ecosystem functioning [7]. Therefore, the study aims to assess the response of water level depth to vegetation composition in degraded peatland.

2. Methods
The study is used a prospective observational approach in real environmental situations. The research started from September 2 to October 7, 2020 using the observation box with an area of 3 x 3
m located at coordinates (latitude, longitudinal): -3.1633606 S, 104.5461407 E. In the observation box, five monitoring wells were made using a pipe size of ¾", planted vertically at each corner point of the observation box and its center (Figure 1).

Variable measurements are carried out at intervals of seven days. The water level depth (WLD) is calculated per quadrant using the average value of the four corners of the quadrant. For example WLD of quadrant I is calculated by the equation:

$$WLD_{in} = \frac{1}{4} \times \left[ WLD_{Cn} + WLD_{En} + \frac{1}{2} (WLD_{Bn} + WLD_{Dn}) + \frac{1}{2} (WLD_{Cn} + WLD_{Dn}) \right]$$  \hspace{1cm} (1)

Where WLD: Water Level Depth; A, B, C, D, E: monitoring-well index; n: sequence of measurements; and I: quadrant index I. The amount of species is counted manually and differentiated by plant growth form (a tree or else). Whereas the composition is measured by proportion of tree in particular quadrant.

3. Results and Discussion

The location has elevation of 16 m.a.s.l, with a peat depth of 407 cm - consider as deep peat level - whereas the covering layer as depicted in Figure 2. Of four-week observation, Quadrant II seem experienced more water level changes compared to other quadrants that were 48.75 (II) vs. 24.25 (I), 34.37 (III), and 17.25 (IV) cm. The study found some irregular patterns of the water level changes. During the first week, the water level in Quadrant II has slightly dropped while the other quadrants have raised. Whereas in the last week, only Quadrant IV that found has fallen in the water level while the others have increased. At the end of the observation, Quadrant II had water level the closest to the peat surface, followed by Quadrant III, Quadrant I, and the last was Quadrant IV (Figure 3).
At least fourteen species identified in the observation box with the majority in the form of an understory plant (Table 1). Of the understory plant, Melastoma malabathricum was the most followed by Lepironia articulata, Dicranopteris linearis, and Imperata cylindrica. Of the trees, Melaleuca leucadendra and Vitex pubescens were the most. The trees have different root system. For example, Artocarpus kemando has strong and deep taproots and side roots. Artocarpus altilis has taproots that grow downward and side roots that grow shallow. Alstonia scholaris has taproots with rooting depth over 150 cm \cite{8} and has the presence of porous lenticels on its. The roots of Melaleuca leucadendra consist of taproots that straight and extending downward, lateral roots that growing on the root neck at the beginning of growth, and secondary roots that spread at a depth of about 20 cm below the soil surface. Dicranopteris linearis has a rhizome (tuber) widely creeping \cite{9} that grows near the ground and has a hard, hollow stem to help distribute oxygen and foodstuffs. By vegetation composition, Quadrant I had a proportion of tree around 7.5%, Quadrant II had around 16%, Quadrant IV had around 30%, and Quadrant III had none (Figure 4).

**Table 1. Species diversity in the observation box**

| Plant Species (Code in Figure 4.) | September 2rd, 2020 | September 30th, 2020 |
|-----------------------------------|---------------------|----------------------|
| Alstonia scholaris (1)            | 1                   | 1                    |
| Artocarpus altilis (2)            | 1                   | 1                    |
| Artocarpus kemando (Miq.)(3)      | 1                   | 1                    |
| Dicranopteris linearis (4)        | 9                   | 9                    |
| Ficus sp (5)                      | 1                   | 1                    |
| Imperata cylindrica (Raeusch.) (6)| 7                   | 9                    |
| Lepironia articulata (7)          | 9                   | 13                   |
| Lygodium cinnatum (8)             | 3                   | 5                    |
| Melaleuca leucadendra (9)         | 3                   | 3                    |
| Melastoma malabathricum (10)      | 31                  | 31                   |
| Nepenthes mirabilis (11)          | 1                   | 1                    |
| Pennisetum purpureum (12)         | 2                   | 4                    |
| Stenochlaena palustris (Bedd.)(13)| 3                   | 3                    |
| Vitex pubescens (Vahl)(14)        | 3                   | 3                    |
Figure 4. The relative position of species
(No. refers to table 1.)

Comparing the tree's proportion against the water level, one readily assumed that the water level had not responded to vegetation composition but rather to the species' root system. *Melastoma malabathricum* density was inversely related to the soil saturation level [10], which possibly caused Quadrant I had more water depletion compared to Quadrant II. Dicranopteris-dominated understory led to decreased soil temperature and increased soil moisture [11] that helped maintain the Quadrant II water level as close as possible to the peat surface, aside from the taproots system of the consisted tree within Quadrant II. The absence of a tree in Quadrant III suggested made the soil less water-penetrable-able. Statistical hydrology is necessary to evaluate the peatland water level [12] that is important to control run-off production, plant growth, and carbon cycling [4]. Due to the plant community's delayed response to short-term changes in environmental conditions, vegetation showed the weakest correlations to the tested environmental parameters [13]. Even though species composition could use as an indicator of an outcome of restoration treatment [14], the current findings should view as a basis for future assessment since there is no historical data of the sites as references.

4. Conclusion

The study concluded that the water level is likely to respond to species’ roots system rather than vegetation composition.

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