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# Land And Water Management In Pineapple And Albizia Chinensis Agroforestry Systems In Peatland

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**Abstract**:

Fires of land and forests on peatland occur every year. This problem is triggered by the burning of land that is not cultivated or the business of land clearing by a community group that does an open fire which is less costly. Because of this condition, people need to find alternative efforts to use peat without burning the land. The agroforestry model is an effort carried out by utilizing the land for wood industry plants, and the seasonal crops (agriculture) are planted among the main crops. This effort encourages partnerships between private parties and local residents. Field applications have been carried out in the Sumatra Alam Anugrah LLC concession area, in Gumai Village, Teluk Rumai Village, Gelumbang sub-district. *A. chinensis* plants are used as main plants, while pineapple plants are intercrop plants, which are expected to contribute to the income of local residents. Results of the study showed that soil characteristics were characterized by porosity ranging from 90 to 95% and soil content of 0.2 gr / cm3. The movement of water in the soil was very fast. In order to manage the land and water of the study area, it is suggested to apply a concept of water control that is shallow drainage, namely the primary channel that has a depth of 2 m, the secondary channel, and tertiary channel that was made with a depth of 1 m. In the plot of the land, a worm channel (micro channel) is made with a distance between 30 m channels and a depth of 40 cm. With this shallow water system, the depth of the groundwater can be maintained at an altitude of 30 to 40 cm, so that it is suitable for pineapple growth and also prevention of land fires.

*Keywords: peatland; water system; pineapple, agroforestry*

## 1. Introduction

Peatlands in Indonesia are estimated to reach 20.6 million ha [1], which is around 10% of Indonesia's land area, [2]. The location of peatlands is widespread, especially on the islands of Sumatra, Kalimantan, and Papua. In line with population growth, the limited land has encouraged the conversion of peatland into agricultural land in supporting food security, fulfilling the raw materials of the paper industry, fulfilling the needs of plantation areas for bioenergy development and residential settlements. The most prominent efforts to utilize peat land today are the conversion of peatland to pulpwood of industrial forest ( in Indonesian called “HTI”) and oil palm plantations [3]. The opening of peatland for plantation purposes and HTI through canalization has caused excessive water table depletion. And it has an impact on increasing carbon emissions and is prone to fire [4]. It is reported by [5] carbon emissions from peatlands burn up to 40 times more rather than non-peat land.

Peatlands have several strategic functions, such as hydrological functions, as carbon sequesters and biodiversity, which are essential for the comfort of the environment and animal life. On the other hand the various environmental condition would have different approach for maintenance and operation in term of land development [6]. Peatlands are classified as marginal and "fragile" land with usually low productivity and very easy to experience damage. Agricultural development on peat swamp to support sustainable development requires careful planning, the application of appropriate technology, and appropriate management. So that there will be a harmonious situation between peat land development and natural resource sustainability. Developing model operation is required in the field level as a tool to minimize infect and increase the land restoration [7][8]. (Conservation and optimization of the use of peat swamps according to their characteristics require information about the type, characteristics, and distribution [9]. Added by [10] the key to peatland use is how the water table is maintained at a depth below 40 cm. At this depth, the water in the capillary area is still enough to wet the upper surface of the soil. So that it takes effort to restore water in the canals from the end of the rainy season.

Therefore the use of peatland must pay attention to various aspects, especially the land and hydrology aspects. Management errors cause the land to be damaged, and often cause land fires in the dry season, due to drought. However, aside from the limitations of dry land, the cultivation of plants is also carried out on peat soil. Land and water management options must pay attention to aspects of efforts to prevent carbon emissions, land degradation, and fire prevention. One model of agroforestry is by greening a combination of food crops and forest plants [11]. For this reason, appropriate technical efforts are needed in managing peatlands. Food crops are expected to be able to maintain groundwater levels below 40 cm in addition to generating income for local residents [12].

Regarding the above, studies of soil and water management technologies are needed in the utilization of environmentally friendly peat waste. The agroforestry model is an effort to use the land carried out in the field study. This model aims to meet water needs for food so that in the process, the business actor always controls the groundwater level to suit the food crops. Therefore excess disposal in the dry season can be minimized because retention efforts have been made towards the end of the rainy season. The purpose of the research is to develop operational steps in the field related to land and water management for the development of agroforestry model in the peatland.

## 2. Materials and Methods

The tools used in this fieldwork were: 1) stationery, 2) peat drill, 3) GPS, 4) Meters, 5) plastic bags and 6) Ring samples**.** The use of peatland refers to Minister of Agriculture Regulation No. 14 of 2009, where it is said that peatland that can be managed is in areas that have a depth of 3 m. Efforts to reduce groundwater level are carried out with the concept of controlled drainage and shallow drainage [22]. In this case, the channel made first is a secondary channel connected to a natural river (the river is considered primary). This secondary channel serves as navigation and also removes excess rainwater. The vertical straight channel is made of tertiary channels with a depth of 1.5 m and a width of 3 m. This channel has only been made 1 unit to cover an area of 10 ha. To dispose of runoff water is carried out by a shallow, dense drainage system (micro channel) perpendicular to the tertiary channel. The distance between quarter channels (worm trenches) is 30 m with a channel depth of 30 cm and a width of 50 cm [13].

In addition to land management activities in the field include measuring the depth of groundwater, and taking soil samples. Furthermore, activities in the laboratory include analysis of the physical properties of the soil, namely measurement of weight, pore space, and soil water content.

Observations on plant growth were carried out directly on staple plants and intercrops. The main forest plants *A. chinensis* and intercropping plants are pineapple (*Ananas comosus*).

## 3. Results And Discussion

### 3.1 General Condition

The research study area is peatland, which cultivates *A. chinensis* plants as the main crop and pineapple plant (as an intercrop). In this land, the intercropping system is applied. Intercropping system is a form of cropping pattern that cultivates more than one type of plant in a particular time unit, and intercropping is an effort of an agricultural intensification program with the aim of obtaining optimal production results and maintaining soil fertility. The purpose of intercropping is to optimize the use of nutrients, water, and sunlight as efficiently as possible to get maximum production. A few things that must be considered include setting the spacing, plant population, harvest age of each plant, and plant architecture.

As one type of swampland, the presence of water on peatland is strongly influenced by the presence of rain and tides/overflow of river water. The behavior of both, will affect the height and length of water flow on peatland and ultimately will affect the level of soil fertility and crop cultivation patterns that will be applied to it. Peatlands that often receive river overflows are relatively more fertile compared to peatlands which solely receives rainwater runoff. The overflow / tidal nature of the river which can reach its duration can be dealt to overcome various obstacles in agriculture on peatland, for example, to wash toxic substances or strong acids from the oxidation of pyrite and regulate the presence of water so that plants can grow well.

For the time being, *A. chinensis* plants that have been planted are around 209 tree seedlings that began in 2017. For the layout itself, there are still around 4,393 ha that has not been planted and are still in the form of protected forests.

### 3.2 Land conditions

The soil conditions in the peatland area were observed by analyzing the chemical properties, physical properties, and biological properties. There are two sources that contribute to the diversity of soil fertility, namely rainwater and minerals from the land. Peat that is dependent on rain sources has low fertility while those affected by terrestrial minerals have relatively high fertility.

Soil that is located on land is mostly organic soil and only has a small portion of the mineral. Organic soil is formed from deposits of organic matter in the form of weathered past growth, while mineral soils are formed from the formation of kasai. The depth of peat soil in the study area is between 2.0 and 2.7 m. Thus it is suitable for cultivating agricultural cultivation.

In the area of the study shows that the lands in the area are mostly organic soil, organic soil is formed from deposits of organic matter in the form of weathered plants of the past. To achieve the stability of the physical properties of peat trees it takes at least 2-3 years, by clearing land, making channels, compaction and decreasing peat surface, and good crop patterns.

### 3.3. Physical properties of soil

Characteristics of peatland in this area are medium to very deep peat with sapric level of maturity. The land still stands at the time of the rainy season with no drainage conditions. The peat soil needs several years (at least 2-3 years) to reach a level of stability in its physical properties. This land improvement can be in line with land clearing for compaction and land-lowering channels.

In an effort to use land use especially peat, some things must be considered the physical properties of peat soils that affect its cultivation, namely bearing capacity to reduce subsidence, irreversibility, high water content with very low content weight

The bearing capacity of peat soils is generally very low. It is closely related to the very low weight of peat and the low support capacity of plants, especially the annual plants do not support themselves well so that the plants easily collapse and tilted. With this, it is necessary to improve the land by making drainage channels. The making of this drainage channel will accelerate the process of weathering organic matter and decreasing subsidence.

#### 3.3.1 Bulk Density and Pore Space

Content Bulk Density is the weight of the unity of the volume of the soil dried oven (g $cm^{-3}$). The weight of the soil varies depending on the density of the soil particles. The weight of the soil can be used to show the boundary values of the soil in limiting the ability of the roots to penetrate the soil and for root growth, the soil porosity is influenced by the content of organic matter, structure, and soil texture. The results of the analysis in the laboratory are as follows:

Table 1. The results of the analysis of Total Weight and Pore Space in the Laboratory
In pineapple plantations

| Observation point | Depth | Total weight* (g/cm$^{-3}$) | Total pore space (%) |
|---|---|---|---|
| $T_1$ | 0-30 cm | 0.22 | 91,7 |
| $T_2$ | 0-30 cm | 0.13 | 95,1 |
| $T_3$ | 0-30 cm | 0.19 | 92,9 |
| $T_4$ | 0-30 cm | 0.19 | 92,5 |
| $T_5$ | 0-30 cm | 0,3 | 95,1 |

* Data is based on the results of analysis in the Physics and Soil Conservation laboratory, Soil Science Department, Faculty of Agriculture, Sriwijaya University

### 3.3.2. Soil Color

The color of the soil functions as a pointer to the nature of tana, because the color of the soil is influenced by the factors that are present in the soil. Determination of soil color is carried out directly in the field using a guide directly from the Munsel Soil Color Chart book with moist soil conditions and good sun exposure, the observation point is determined based on the specified location. The results of the observations are as follows:

Table 2. Soil color at the study site in pineapple plantations

| Observation point | Depth (cm) | Color | Legend |
|---|---|---|---|
| $T_1$ | 0-30 | 10 R | Reddish black |
| $T_2$ | 0-30 | 2,5/1 | Reddish black |
| $T_3$ | 0-30 | 10 R | Dull red |
| $T_4$ | 0-30 | 2,5/1 | Reddish red |
| $T_5$ | 0-30 | 10 2 | Reddish brown |
| | | 2,5/2 | |
| | | 10 R | |
| | | 2,5/1 | |
| | | 5 YR 3/2 | |

### 3.2.3. Soil Permeability

Permeability is the ability of a land to pass water and air in the soil. A characteristic of land that can show the land woman passes water. permeability is the ease of fluid, gas and roots penetrate the soil. The results of observations and calculation of permeability values in the field are as follows:

Table 3. Results of analysis of soil permeability in laboratories in pineapple plantations

| Observation point | Point | Soil Permeability (cm jam$^{-1}$) | Criteria* |
|---|---|---|---|
| $T_1$ | 0-60 cm | 3,2 | Medium |
| $T_2$ | 0-60 cm | 4,6 | Medium |
| $T_3$ | 0-60 cm | 3,9 | Medium |
| $T_4$ | 0-60 cm | 3.4 | Medium |
| $T_5$ | 0-60 cm | 3.2 | Medium |

Based on soil permeability classification according to the Soil Research Center

### 4.2.4 Soil Water Content

Peat soil has a relatively high binding capacity or holding water on the basis of dry weight. The maximum water-binding capacity for fibric peat is 580 to 3000%, for hemic peat 450 to 850% and for sapric peat is under 450%. Peat will turn hydrophobic (water repellent) if it is too dry. Reported by [14] that the rise of capillary water in peat soil reached a maximum height of 50 cm which was indicated by the increase in water content at the top layer in the range of 105–127%, This mean that water content was entered to the critical soil moisture content, and highly risk to have land fire.

Groundwater content at a depth of 100-150 cm has a greater level than the soil water content at a depth of 50-100 cm. While the lowest soil moisture content is at a depth of 0-50 cm. So the depth of the solum or soil layer determines the volume of stored groundwater, the deeper the soil layer the higher the water content of the soil. This is because the deeper the soil layer, the lower the maturity of the peat, so that the soil can hold more water. According to [15]_stated that the ability to absorb and retain water from peat depends on the level of maturity. The ability of peat soil to absorb and bind water to fibric peat is greater than hemic and sapric peat, while hemic peat is larger than sapric. On the other hand also the change of land use patterns result changes in the hydrological system, erosion upstream and downstream sedimentation, decline biodiversity, reducing the ability of carbon absorption and direct emissions from carbon dioxide and greenhouse gases [16].

Whereas according to [17] groundwater availability is not only based on maturity, but also by rainfall or irrigation water, the ability of the soil to hold water, evapotranspiration, and groundwater level. Water content is affected by the density of the soil, because the soil holds less water

Table 4. Percentage of water content in the study site on pineapple plants

| Observation point | Depth (cm) | Water content (%) |
|---|---|---|
| T1 | 0-30 | 354 |
| T2 | 0-30 | 470 |
| T3 | 0-30 | 414 |
| T4 | 0-30 | 394 |
| T5 | 0-30 | 551 |

### 3.6. Principles of Water Management in Peatlands

Water management on peatland must consider some very specific characteristics of peat, including the ability of peat that is very high in absorbing water (hydrophilic) that can turn into hydrophobic (water repellent) if the peat has undergone irreversible drying. This condition occurs if peat experiences extreme drought. According to [18] the decline in the ability of peat to absorb water is related to the decreasing availability of hydrophilic compounds in peat material, namely carboxylic and OH-phenolics. These two organic components are in the liquid phase of the peat so that if the peat is dry (due to excessive drainage), the hydrophilic nature of the peat soil will not function.

Channel dimensions (primary, secondary, and tertiary) must also be adjusted to the area and commodity area developed [19]. For example, annual crops (food and vegetables) require relatively shallow drainage, which ranges from 20-30 cm, while annual plants require deeper groundwater depth, and vary between annual crops. Ground conditions that are too shallow cause rooting cannot develop due to poor aeration conditions. If the organic acid content in peat water is too high, plant growth can also be inhibited and cannot even grow due to organic acid poisoning. On the other hand, in conditions of too deep groundwater, the peat becomes dry, so that plant growth becomes depressed because of the limited availability of water.

The principle of regulating water on peatland must also take into account the impact on the rate of decomposition of peat. Reported by [20] illustrates the linear relationship between water level in the drainage channel and the rate of peat emissions as an impact of increasing the rate of decomposition of peat, meaning that the deeper the water level in the drainage channel, the higher the rate of emissions from peatland. into 120 cm. This means that the relationship between emissions and drainage depth is not always linear, at a certain depth the emission rate decreases again, possibly in conditions that are too dry peat decomposer microorganism activity decreases again. However, the chances of increasing emissions remain high due to the higher risk of peat fires.

Therefore, the main principle of regulating water on cultivated peatlands for agricultural crops is to be able to suppress the degradation of the environmental function of peatland due to the process of drainage/groundwater reduction, but still be able to fulfill the requirements for growing cultivated plants. Therefore, the groundwater level must be regulated to a minimum where plants are still able to grow properly. This means that the groundwater level must be arranged so that it is not too shallow and not too deep. This can be done if there are available control facilities in the form of sluice gates in each channel, especially if peatland development is carried out on a large scale.

Management of water resources on peatlands is very important. In addition to C absorption, the presence of water on peatlands also functions as a source of freshwater in a significant volume, reaching 8 to 13 times the volume of the peat itself. Water is an important factor in the process of forming peat domes, and drainage (although not always) is the cause of subsidence. Besides that, peat will become very fragile after experiencing fragile and flammable processes, so management of water on peatlands is very important to note.

In the management of water on peatlands, the most important thing to note is the groundwater level. The groundwater level must be maintained at 40-50 cm below surface so that the land is not too wet for crop and also must be able to maintain the moisture of the peat so that the peat does not experience drought.

Peatlands have high hydraulic conductivity, both vertically and horizontally. The data is very important to calculate how quick the water losses [21]. To find out the data is required the direct field measurement. Reported by [22] that in tropical peat soil hydraulic conductivity data should measure directly in the field rather than calculation by computer model. The value of hydraulic conductivity in tropical peat soil was varied (*c.* 0.001–13.9 m $d^{-1}$). Therefore, developing channels system are needed that can help smooth irrigation and drainage of peatland areas. The key to controlling groundwater level is to regulate the dimensions of drainage channels, especially their depths, and regulate sluice gates. According to [8] water conservation has to be applied in the field. Since March the gate should permanently closed to retain water as much as possible.

### 3.5 Pineapple Agroforestry Land Arrangement System

Pineapple cultivation in the peatland area requires a reclamation network in the form of channels and sluice gates so that land can be used for various purposes as a place of transportation by using canoes to transport plantation tools or to work with workers. There and as a means of watering for the *A. chinensis* plant itself.

One of the essential components in regulating peat water systems is a control building in the form of sluice gates on each channel. The floodgates function to regulate the groundwater level so that it is not too shallow and not too deep. Plants need drainage channels with different depths. According to [23] control drainage is the best option for water management in peat soil. By flap gate the water from secondary canal (main drain) could enter to the tertiary canal (water supply). When the low tide the gate will automatically closed by water force. This mechanism could create full water in the tertiary canal. To avoid over drainage the culvert should installed in 20-30 cm below the average soil surface.

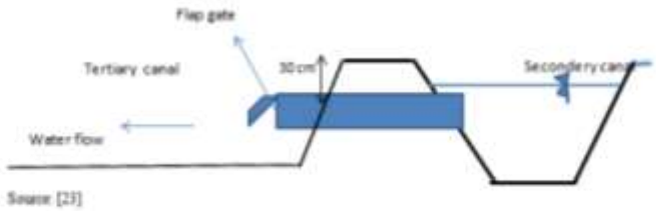


Figure 2. Flap gate installed with combination culvert to control drainage

Water table depth was strongly determine the value of capillarity. When the water table maintenance between 40-50cm the crop water requirement was supporting by water capillary rise. Generally in mineral soil the water table depth more than 100 cm was required supply water [23]. The peat soil is high porosity than the water table should be maintenance under 40-50 cm. In this level the capillaries water could make the root zone under field capacity, and food crop growth properly. Therefore the agroforestry is the best way how to manage peat land by maintaining the water table suitable for food crop and minimize fire hazard [10].

The deeper the drainage channel, the faster the surface subsidence and peat decomposition will be, so that the thickness of the peat will, and the buffer against the water will decrease. Reported by [24] that strong correlation between water-table depth and subsidence. It was high significant value (r = 0,824). Peat land cultivated by oil palm after 18 years drained has get subsidency 5.4 cm year-1. The deep of ground water table means increasing peat subsidency caused by oxidation as well as increased vulnerability of peat mechanics to fires.

On the ground there is already a drainage channel starting from the primary channel to the worm canal, making it easier for the irrigation process of the plant. This drainage channel does not function as irrigation but also functions as a transportation tool to transport the harvest from Sumatra Alam Anugerah LLC's land.

To expedite the entry and exit of water in the plot of land which at the same time to wash out toxic materials, [9] recommends making worm channels in plots and around the plot of land. Therefore, micro-water management includes the arrangement and management of water systems on quarter channels and plots of land that are suitable to the needs of plants and at the same time, facilitate the washing of toxic materials. According to [23], quarter channels are usually made at each boundary of land ownership, while worm channels are in plots with a distance of 3−12 m and around the plot, depending on the condition of the land.

One of the most important in regulating peatland water systems is a controlling building that is a sluice gate on each channel. The floodgates function to regulate the groundwater level so that it is not too shallow (dry) and not too deep (full). Pineapple plants need a drainage channel as deep as 50-80 cm. For this research area, sluice gates are available outside the research area, namely in the area of land that directly empties into the tributary of the Musi River.The water system in the land is affected by the tide that enters the primary channel. and continues to the secondary channel which then enters the tertiary channel and moves to the worm canal.

Table 5. The dimensions of the drainage channel in the peatland research area of Sumatra Alam Anugerah LLC

| Channel type | Width (m) | Depth (m) |
|---|---|---|
| Primery | 6 | 1 |
| Secondary | 3 | 1 |
| Tertiary | 1 | 1 |
| Worm | 0,6 | 0,4 |

In the peatland practice area, the existing channels are made to support the growth of the plants cultivated in the area. The channels that exist in the water system have the primary goal of removing excess water and maintaining the desired groundwater level of the cultivated plants.

This cultivation system uses an intercropping method where the main plants of *A. chinensis* plants and plants are pineapple plants so that irrigation and drainage systems need to be done. Irrigation and drainage systems are very much needed in the business of cultivating crops on peatland. Irrigation and drainage can be useful in meeting water if the land is dry and can remove water if the land is excess water. The distance between secondary channels to tertiary channels is 100 m. Every distance of 50 m there is a worm channel. The land contains *A. chinensis* plants as the main plant, while intercropping is a pineapple plant, so the water needs on the land are beneficial.

### 3.4.1 Primary Channel

The primary channel is the main network that is directly related to rivers or dams. The primary channel in this study area has a width of 6 m with a depth of 1 m, this primary channel also functions as the entry and exit of water in the river, and also used as a means of transportation to transport plantation products from the company.

### 3.4.2 Secondary Channel

After the water enters the primary cannal then enters the secondary channel. The secondary channel is a channel that is directly related to the primary channel, the secondary channel functions as an irrigation water provider and for removing water or drainage. In the study area, secondary channels have a width of 3 m with a depth of 1 m.

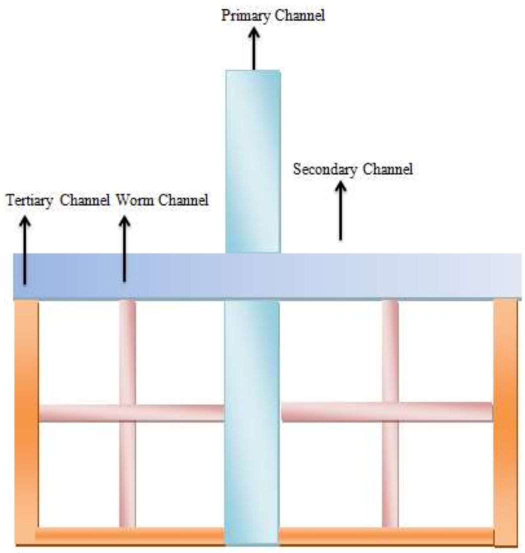


Figure 2 Water management system at Sumatra Alam Anugerah LLC

### 3.4.3 Tertiary Channel

Tertiary channels are channels that are made perpendicular to and directly related to secondary channels. This channel functions as a channel that carries water into and brings out water from tertiary channels to secondary channels. In the study area tertiary channels have a width of 1 m with a depth of 1 m.

### 3.4.4 Worm Channel

The worm channel is a channel that is connected to tertiary channels. This channel is made to controlling the movement of water present in cultivated plants. In the area of research, the worm channel has a width of 60 cm with a depth of 40 cm.

### 3.5 Water Management

Micro water management systems function to: 1) meet the needs of plant evapotranspiration, 2) prevent weed growth in lowland rice plantations, 3) prevent the formation of toxic materials for plants through flushing and washing, 4) regulating water level, and (5) maintaining water quality in land plots and channels. Water management in tertiary channels aims to: 1) incorporate irrigation water, 2) regulate water level on channels and plots, and 3) regulate water quality by removing toxic materials formed in the plot and prevent saltwater from entering the plot of land. The water management system at tertiary and micro-level depends on the type of tidal overflow and the level of hidrotophografi [25]. Added by [13] it is required hydraulic structure in the tertiary cannel to control water table. The structures developed should consider the local material which technically easy, socially accepted and environmental friendly.

The thing that needs special attention in the water system is synchronization between macro and micro water systems [23]. The application of one-way flow will only be useful if the conditions of tertiary, secondary and primary channels are in good condition and the direction of flow is not alternating. In one-way flow systems, irrigation channels and drainage channels are designed separately. The flapgate is installed in the opposite direction. In the irrigation canal, the valve door opens inward while in the drainage channel the valve door opens to the outside so that land washing is effective.

### 3.6 Network Operation

This network operating system has not functioned optimally because the water-gate has not yet been formed, which functions to regulate the entry and exit of water. During the rainy season, the water in the channel will be excess while during the dry season the water in the channel will be a little water. As for the channel, there are primary, secondary, tertiary and worm channels that are all well connected.

### 3.7 Potency of Peatland for Pinnape Plantation

Peatlands of 1.5-2 m depth are classified as marginal (S3 suitability class) for various types of plants. The main limiting factor is the condition of nutrient root media that does not support plant growth. The peatlands found in the area are used to cultivate *A. chinensis* plants and their plants are planted with pineapple. Pineapple plants are quite potential, this plant is also not too difficult to cultivate Pineapple plants are the most acid resistant plants (Figure 3). Pineapple plants can grow on soil pH 3.0 with plant growth and produce well. This is the reason why pineapple plantation is done on peatland because it has a low level of soil fertility.

Figure 3. Pineapple and *A. chinensis* plants in the Agroforestry model on Sumatra Alam Anugerah LLC peatlands

In the use of peatland in the study area, *A. chinensis* plants became the main crops cultivated by planting pineapple plants as intercropping plants. This plant was chosen because it is known that pineapple is a fairly potential and promising annual crop to be cultivated. The production of fruit from pineapple plants is very much in demand by consumers for various uses such as raw materials for making jams etc. While for the main plants, *A. chinensis* trees are planted. *A. chinensis* plants are very easy to grow on peatlands. The company got the seedlings of plants by buying seeds from farmers around the Gelumbang area with the price of 200 rupiah / seed ready for planting. In general, pineapple planting is done manually by using simple tools such as hoes. Seeds are planted in planting holes that have been provided as deep as 5-10 cm.

In general, the dosage of fertilizer is adjusted to the needs of the plant itself and the fertility of the land. At the beginning of planting, a basic fertilizer of 3-5 tons/hectare is given by being taken away. After the growth period of the fertilizer is given again at the beginning of the dry season and the beginning of the rainy season. At the last observation in August 2018 the age of pineapple plants has reached 10 months.

### 3.8 Height of Water Table

The measurement of water level is the measurement of the position of a thick surface of water against a reference (ground level). Measurements are carried out in units of cm. Groundwater depth on peatlands is influenced by water level (TMA) in the drainage channel [8]. Emissions from peat soil can be suppressed if the peat is saturated or the groundwater depth fluctuates slightly near the surface. Some research results show a positive correlation between the depth of the water table and CO2 emissions. Reported by [28] that the relationship between drainage depth and emission rate is not always linear. The optimum water table depth for oil palm plants on drained peatlands ranges from 60-85 cm.

This water level measurement is done by measuring from one channel to another channel. It turns out that after measuring the length of one channel to another channel is 100m. The observation point we did at every distance of 10m we measured the surface height. This measurement is done by drilling a point using a 80 cm deep peat drill and then inserting the measuring instrument, our measuring instrument uses the meter that is inserted into the drilling results. In this water level measurement activity we did three replications so that we got thirty points.

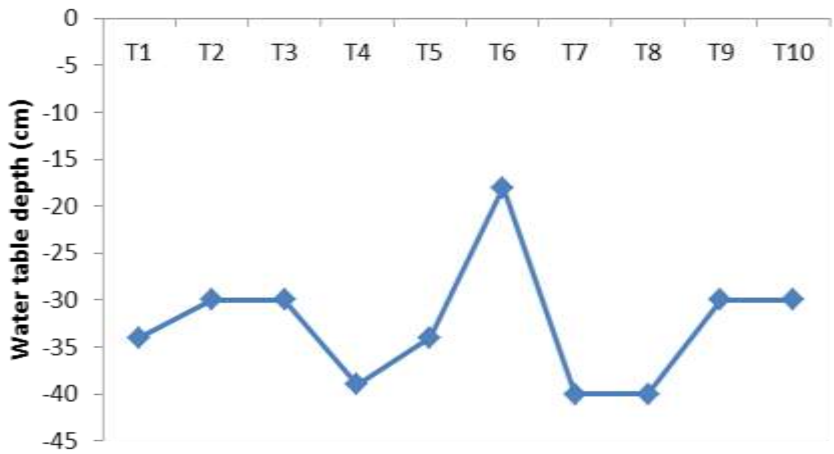


Figure 4 First Observation points

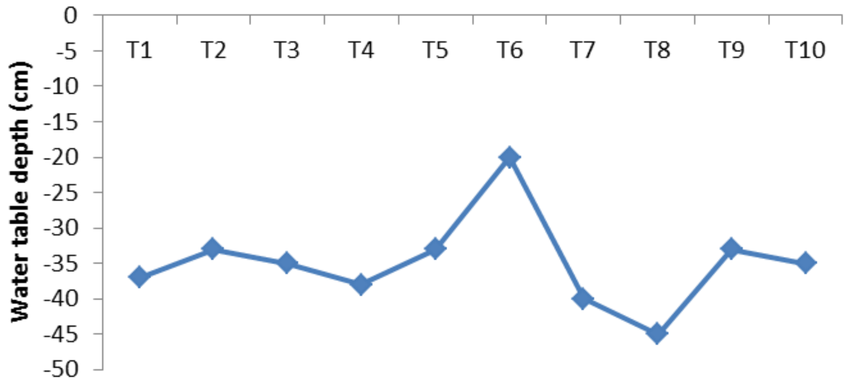


Figure 5 Second Observation points

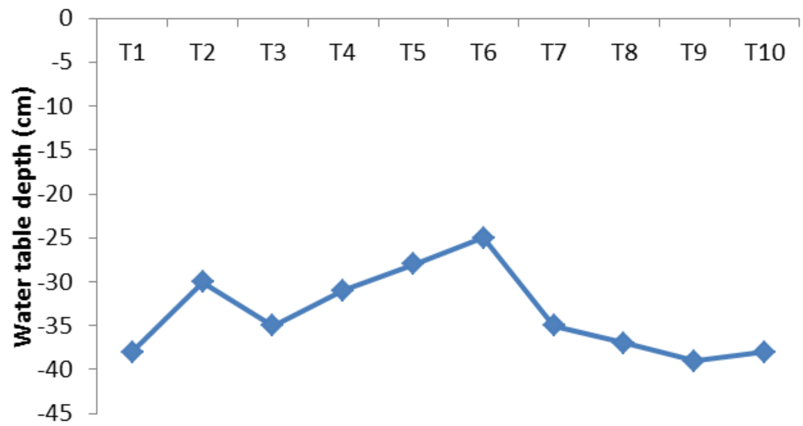


Figure 6 The third observation points

At the observations, we have done three times the repetition of the results of the water level does not differ too much from around 30-40 cm. This is still following government regulation No. 57 of 2016 concerning Protection and Management of Peat Ecosystems which limits the minimum peat water level by 40 cm. According to the research of [28] the depth of groundwater maintained at the level of 40 cm besides being able to create the condition of moist peat soil (not burning) can also reduce the rate of subsidence by 25-30%. It was added that the rate of CO2 emissions increased by 20%, 56%, 100% and 162% when there was a decrease in groundwater levels from 0 to 40 cm [29].

According to [30] peatland fires from July to October 2015 in Indonesia reached approximately 623,304 ha, of which about 270,691 ha (43%), 320,756 ha (51%) and 31,857 ha (5%) were located in Sumatra, Kalimantan and Papua, respectively. Assuming the largest carbon gas emissions released by burning biomass (CO2, CO, and CH4), the total carbon released into the atmosphere during the four months of fire is to be about 0.002 Gtonnes, of which 81% was in the form of CO2; 16% CO and 2.3% CH4.

The condition of the peat water table is influenced not only by the opening of drainage channels but also by climate factors, especially rainfall. The groundwater level will affect the maturity and decomposition of peat soil. As mentioned by [31]. that regulation of macro water systems and micro-water management greatly influences the characteristics of peatlands. Groundwater level will affect the decomposition of (irreversible) subsidence and dry (subsidence). Reported by [23] that the holding of water in a channel on peatland planted with oil palm in the period of August to Early October was able to create an average water level at a depth of 59, 67 cm below the surface of the land with the number of days dry (> 40 cm) is 120 days. This means that as many as 245 days the groundwater conditions are below 40 cm (meeting government regulatory standards).

The following table presents monthly recommendation for operating a water table control in the field to achieve the water level suitable for crop and fire prevention.

Table 6. Farmer guide to operate the hydraulic structure in tertiary and secondary canal of peat land development

| Operation model | month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Control drainage 30-40 cm | X | X | | | | | | | | | X | X |
| Retention water (conservation) | | | X | X | X | X | X | X | X | X | | |
| Retention+ suplay water | | | | | | X | X | X | X | | | |

## 4. Conclusion And Suggestion

### 4.1 Conclusion

Based on the results and discussion of this study, it can be concluded that:

1. The peat land in the area of research has been included in the sapric maturity, that is, part of the land has been decomposed.
2. The water management system in the research area has excavation of primary channels, secondary channels, tertiary canals and worm channels.
3. The water treatment system in the Sumatra Alam Anugerah LLC land has not run optimally.
4. The management of the water system is not only used as watering for cultivated plants but is also used as a means of water transportation to transport the equipment needed in the field and transport workers by boat.
5. Inter cropping system by Agroforestry model (pineapple and A. chinensis) have a good prospects in term of peat conservation and fire prevention model. By applied the hydraulic structure in the field the ground water level was maintained at 40-50 cm below surface. Monthly operation showed that control drainage should applied during the rainy season, and retention options should start in March to June, and during the dry season has to find out water supply.

### 4.2 Suggestion

It is recommended that the water system be more optimized so that it can function as well as possible and benefit the plants that will be cultivated. Especially for sluice gates that should be made in order to control the entry and exit of water.

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