The 2nd Universitas Lampung International Conference on Science, Technology and Environment

Secretariat: Institute of Research and Community Service, Universitas Lampung
Jl. Prof. Dr. Ir. Sumantri Brojonegoro, RW.No: 1, Gedong Meneng, Kec. Rajabasa, Kota Bandar Lampung, Lampung 35141
Email: ulicoste01@kpa.unila.ac.id Web: https://ulicoste.unila.ac.id/,

LETTER OF ACCEPTANCE

Dear Mr Amril Ma'ruf Siregar, et al

Thank you for submitting your manuscript for presentation at The 2nd Universitas Lampung International Conference on Science, Technology and Environment (ULICoSTE) 2021, *"Promoting Synergy Trought Collaborative Research in Science and Technology for Digital Transformatio"* to be held online on August 27 - 28 , 2021 at Bandar Lampung, Indonesia.

Your manuscript entitled: **"Ponds Function Revitalization As Water Supply To Increase The Productivity Of Palm Processing Factory Of Bekri Business Units "** has been peer-reviewed and accepted, Congratulations! Please be advised that your manuscript is recommended for publication in **(International Conference Proceedings (AIP) - Indexed Scopus)**. For further information, please visit our official website at https://ulicoste.unila.ac.id/.

We look forward to seeing you at the Conference.

Kind regards,

ULICoSTE 2021 Committee

Website	: https://ulicoste.unila.ac.id/
Email	: ulicoste01@kpa.unila.ac.id
Contact Persons	: https://wa.me/6281559678993 (Sofyan)
	https://wa.me/6282281853216 (Nur Hayati)

Ponds Function Revitalization As Water Supply To Increase The Productivity of Palm Processing Factory of Bekri Business Units

Amril Ma'ruf Siregar[1,a], Nur Arifaini[1], Ika Kustiani[1], Mujiyanto[2]

[1] *Civil Engineering Departement, Engineering Faculty, University of Lampung, Indonesia*
[2] *PT. Aman Jaya Perdana, Lampung, Indonesia*

Author Email
amrilmaruf85@eng.unila.ac.id

Abstract. Bekri Business Unit is one of the palm oil factories owned by PT. Perkebunan Nusantara VII (Persero) located in Sinar Banten Village, Central Lampung. The processing capacity of the factory is 50 Tons/Fresh Fruit Bunches/Hour. However, since the 2014 – 2020 period, the average mill capacity was only 38.21 Tons/TBS. One of the problems faced is the lack of water supply for the treatment process, while the potential for managed water comes from ponds as reservoir that are available near the factory site. There are four existing ponds locations, while only one pond is operated because the other ponds have become sedimentation siltation. Thus, it is necessary to study the revitalization of the function of the ponds so that the volume of water storage can be increased. The calculation process used in this study was water balance concept by calculating the availability of water in ponds and water demand for palm oil processing plant. The results of data analysis and calculations show that the consumption of palm oil processing utilities into CPO in factory at the research site is 1.73 tons of water/FFB where normal conditions require 1.8 tons of water/FFB. The results of field measurements show that the existing pond number 4 capacity is 50,482 m^3 with an average water level of 1.5 m in the pond. The storage volume is only able to fulfill the average production for 24 days per month so that it cannot meet the expected production target. Optimization efforts of the existing 4 location of ponds by returning the depth of the ponds to 3 m resulted in an average holding capacity of 207,686 m^3 or an increase of 413.86% from the current pond capacity. Thus, normalization can increase the number of days of production due to the availability of the volume of water that can be used for production by 128,42% the average number of days of annual production and even the excess volume of water storage can be used for other needs.

INTRODUCTION

Bekri commercial enterprise is one of the business units owned by a Indonesian-owned company in the plantation sector, namely PT. Perkebunan Nusantara VII (Persero). The specialty of plantation activities inside the Bekri commercial enterprise is oil palm plantations and processing mills. The area region is Sinar Banten village, Bekri District, Central Lampung Regency. The overall location of Bekri's plantations is 4.324,66 hectares, of which 3.652 hectares are planted areas. In the meantime, the production of FFB (Fresh Fruit Bunches) in factory is 180.616,84 tons for a year. Further to the plantation itself, there's a plasma plantation which is likewise controlled throught by Bekri commercial enterprise, namely Rejosani Plantation with an area of 4.875 hectares and FFB production is 86.288 tons in a year (PTPN 7, 2020). PT. Perkebunan Nusantara VII (Persero) Bekri commercial enterprise also receives FFB material from the most of people across the location.

For processing plants, the Bekri commercial enterprose has a factory with a capability of 50 tons per hour and produces an average annual production of 38,336.07 tons of CPO (Crude Palm Oil) or palm oil, and a production of 7,849.58 tons of PK (Palm Kernel) in a year. In phrases of developing and increasing production capacity, and addition to efficiency of processing capacity, there are numerous obstacles faced, particularly the dearth of water supply for palm oil processing needs. With a load of 50 TBS per hour, it's far certain that factory operations would require a high supply of water to meet production needs. Currently, the palm oil processing plant in Bekri uses water pumped from the reservoir to the factory as a water supply to meet production needs. This reservoir has been used for supplied water for factories since 1978. Therefore, it is need to revitalize the function and increase the storage capacity in order that it can optimize the work of the processing process.

Components of this research will examin numerous related trouble of the existing reservoir as a water source on the Palm Oil Processing Plant inside the processing plant, calculating the water balance of the existing reservoir before normalizing the reservoir, and calculating the water balance of the reservoir after normalization of the reservoir and the resulting benefits for increasing the production capacity of palm oil processing at the processing plant.

This research is likewise expected to provide advanteges to provide to provide the record non the condition of the existing reservoir which is used as the area of the water supply for the Bekri plantation of palm oil processing. In addition, this research also provides guidelines for revitalization of reservoirs to increase the volume of water reservoirs for palm oil processing. The most importatnt this is provide entire information to PT. Perkebunan Nusantara VII (Persero) specially and society in general throught ransferring knowledge and technology to revitalize water reservoirs.

Major function of ponds as a reservoir for rainwater runoff/runoff that occurs in the catchment area in upstream. The area of the ponds was selected primarily based on the natural topographical situations in this type way that it able to keep alot of water as possible with the least amount of reservoir work volume. The renovation of the location of the reservoir have to adaapt to the characteristic of the reservoir as a provision of water needs each as an irrigation water and raw water for the surrounding community (Sudjarwadi, 1987).

A development of infiltration pond is one of the simplest strategies to enchance groundwater resources in artificial manner. Infiltration ponds can accumulate rainwater (which normally flows as water runoff upstream) in several small ponds so that water can seep into the aquifer layer, the layer of soil that can hold water. The accumulated water in the aquifer layer can be applied at some point of the dry season to fill shallow ponds or to increase discharge of springs and meet the water requirement of people residing in downstream region as nicely. For climate change mitigation and adaptation, infiltration ponds also consitute one answer that is easy but probably very effective, and easy to duplicate (USAID, 2019).

In standart, hydrological analysis is a part of the preliminary analysis inside of of hydraulic structures. The exppertise contained there is that the record data and quantities receive from the hydrological evaluation are critical inputs for further analysis. Hydraulic buildings in the field are box culverts, weirs, spillway, flood embankments, etc The size and character of these buildings are quite depending on the cause of construction and the data received from hydrological analysis.

Pond capacity planning is based on the calculation of the planned flood discharge into the pond from the inlet and the inlet and planned discharge. In the meantime, the determination of the minimum water level depends on the ground water level so that seepage does not occur. The total of water of storage in the drainage channel depends on the length (L), width (B) and the depth of water in the channel. Meanwhile, the volume of inundation depends on the depth of inundation that is allowed and the area of inundation that happens

METHODOLOGY

The research site is in the Ponds owned by the Palm Oil Processing Factory owned by PT. Perkebunan Nusantara VII (Persero) Bekri Unit located in Sinar Banten village, Bekri sub-district, Central Lampung district. The data to be studied in this study comes from primary data, namely direct measurements in the field in the form of reservoir mapping data and secondary data obtained from related agencies, including: data on palm oil processing in factories for the period 2014 – 2020, rainfall data closest to the research location.

FIGURE 1. Location Map (PTPN 7. Com/Petasetatis)

The data analysis carried out in this study is to compare the comparison of the availability of water in the reservoir for use in the palm oil processing process in the factory before and after revitalization of the existing ponds. The analysis of data include : maximum rainfall analysis, ground water discharge analysis, potential evapotransporation, run off, and conductivity of soil in ponds.

Maximum rainfall is the largest rainfall in an area and is used by plants for growth. The rainfall is the regional rainfall that must be estimated from the observation point expressed in millimeters. The determination of the maximum rainfall is based on the monthly rainfall from the rain observation station within a period of 1 month. In relation to the data analysis process, the maximum rainfall to be analyzed is obtained from the observation data of the rain station, which then selects the largest value for each month in the analyzed period.

To determine the water holding capacity of the reservoir from groundwater sources, a cumulative storage volume analysis of the volume limited to certain contours is used, with a simple formula published by the Manual for calculating the reservoir capacity. There were 3 stages of analyisis process used, firstly calculating the reference of evapotranspitation value using blanney – criddle method, secondly determining the evapotranspiration coeffieccient value, and thirdly calculating the field evapotranspiration value (Rosadi, 2006). Most empirical models have been based upon domestic sewage and are only for facultative ponds (K.K Wong, 1980). In this study, the determination of the amount of evapotranspiration was obtained from secondary data, namely the reference evapotranspiration from the climatological station closest to the research location., The formula for calculating the area's evapotranspiration rate can be calculated using the equation: ET potential = ET_0/1000 x storage area which ET potential means the magnitude of the evapotranspiration value at the site (m3/month). The ET_0 unit is mm/month so it is converted to meters/month (1/1000).

According to Arsyad (1983), runoff is part of the rainfall that flows out of a drainage area above and below the ground surface.The determination of run off thickness is based on the results of the observation run off test and run off model. According to Sunu Tikno (2012), from 30 rain events, 10 events indicate that rain occurs, more than 50% becomes run off, and the rest is infiltrated. This describes that the soil condition in the watershed is in a saturated position. Conductivity is the ability of soil to allow water to flow through its pores. Soil conductivity is important, to determine the amount of infiltration and percolation that will occur. The conductivity value can be determined by parameter

RESULT AND DISCUSSION

Ponds Existing Condition

There were 4 (four) existing reservoir locations, and only 1 location is currently used for water sources at the factory, namely reservoir no. 4. The reservoir area belonging to PTPN VII (Persero) has been registered as a water conservation area where the reservoir water source comes from rainwater reservoirs and springs from hilly areas around the reservoir.

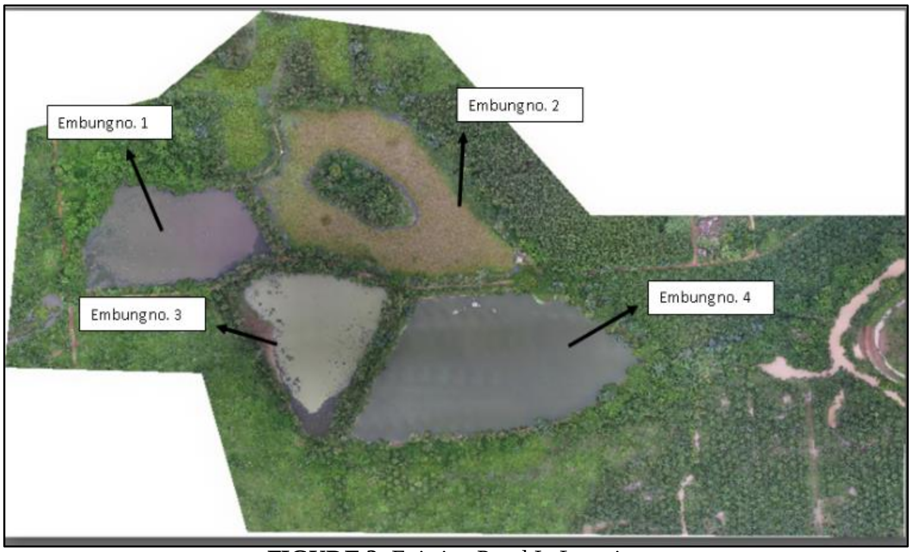

FIGURE 2. Existing Pond In Location

Groups of ponds, natural and/or artiificial, across a landscape are konown ponds capes (Hill MJ, 2016). They are important in conservation effoet, as they support higher community diversity than single large ponds ot reservoir. The main water sources for filling the reservoirs are rainwater and springs from hills near the research site. However, in this study, the study was not carried out on these springs and was only based on rainfall data at the research site. In addition, reservoir no. 1 , 2, and 3 which are also water sources used by PT. Perkebunan Nusantara VII Bekri Business Unit, experienced siltation due to sedimentation and covered by weed vegetation. The water that comes from the storage pond is then channeled to the palm oil processing plant with the help of a pump machine installed on the edge of the storage pond. There are 2 pump units that are operated alternately to meet the needs of palm oil processing in the factory. In general, water footpoint of palm oil production in this study was focuses on palm oil miling process. In the pal oil production the calculation of water footpoint component in the industrial stage only includes the components of blue and grey water because the phases mostly use surface water or groundwater (Herda Sabriyah, 2017). The image below shows one of the pond locations that has become shallow due to sedimentation and the location of the water pump for water supply from the pond to the palm oil processing plant.

(a) (b)

FIGURE 3. (a) One of pond location where silting occurs due to sedimentation. (b) The water pump used to drain water from the pond to factory.

From several literature studies, the water demand for palm oil processing in the mill is based on actual data in the field. However, several previous studies have analyzed the need for water use carried out at each stage of the implementation of oil palm processing (Eka Febria, 2011). However, the amount of water consumption used for palm oil processing in this study will be assessed based on secondary data released by the processing plant to be studied, namely the Bekri Business Unit palm processing plant.

Analysis of water demand for palm oil processing in the mill is obtained from secondary data, namely periodic production reports obtained from PT. Perkebunan Nusantara VII Persero) period 2014 – 2019. As for the results of processing palm oil production into CPO at the PT. Perkebunan Nusantara VII Bekri Business Unit. Table 1 below shows the summary result of processing palm oil into CPO at the Bekri Business Unit Processing Factory from 2014 until 2020 period.

TABLE 1. Summary Result Processing Palm into CPO in Bekri Processing Factory 2014 – 2020 period

Year	**Total Production (Ton)**		**Water Comsumption For Utility (Ton/FFB)**		**Production Capacity (Ton/Hour)**	
	Target	Realization	Target	Realization	Target	Realization
2014	208.000	210.000	1.8	1.5	50	43.16
2015	286.000	255.772	1.8	1.58	50	40.55
2016	105.763	135.240	1.8	1.5	50	41.37
2017	234.125	156.784	1.7	1.59	50	37.06
2018	170.021	180.053	1.6	1.53	50	33.14
2019	214.002	146.933	1.65	1.8	50	33.52
2020	192.511	143.061	1.65	1.59	50	38.64
Average	201.489	175.406	1.71	1.58	50	38.21

Table 1 above showed that in the period from 2014 to 2020 there has been a decline in the amount of production at palm oil processing plants. The results of the realization of the amount of production did not meet the realization target with an average processing capacity of 38.21 FFB/hour. Though the factory's processing capacity is 50 FFB/hour

Basically, the decline in the amount of palm oil production is influenced by many factors, one of which is the supply of water for palm oil processing. For this reason, in this study, the author was examine more deeply the handling of water problems originating from 4 ponds that have been reviewed. Furthermore, the initial study carried out was to analyze the data in the table above and then use it to calculate the water availability analysis in the reservoir based on the water demand for factory processing. The value of water requirements that will be used in this study is the average value of water requirements used for production, which is 1.73 tons/FFB.

Analysis of Water Availability in Embung Existing Condition

Calculation results through mapping analysis and observation of water level in the reservoir area existing is Pond no. 4 which area of inundation 50.023 m^2. The effective depth of filling in the pond based on the assumption of changes in soil elevation conditions every month (LP Unila, 2011). Thus, the assumption of water level at the location of the existing reservoir is based on monitoring the water level during field visits.

Furthermore, the calculation of water availability is carried out based on monthly rainfall data and the calculation of ground water filling at the activity location. The conductivity values taken in this study are based on the results of secondary data searches. The value of the hydraulic conductivity (K) of the soil is the ability of the soil to seep water down a stress gradient. High K values are associated with soils with good structure and continuous prostration. Based on the survey results in the field, the identified soil conditions are clay soil types and the assumption of a slow infiltration rate, with a value of < 2.5 mm/day < 0.025 m/day.

For example, in December, depth of water in ponds are 1,75 m, then the groundwater discharge in the reservoir can be calculated the equation below whic discharge ground water = 0,8 x h x ponds area x k = 0,8 x 1,75x 58.945 x 0,025 = 1.768 m^3/day = 54.819 m^3/month. If the water level based on observations is different every month, then the average groundwater discharge in the existing reservoir is 50.182 m^3 as shown in the table 2 below.

TABLE 2. Summary Calculation of Water Balance in Pond No. 4 Existing

Item/Month	**Jan**	**Feb**	**Mar**	**Apr**	**Mei**	**Jun**	**Jul**	**Ags**	**Sep**	**Okt**	**Nov**	**Des**
Rainfall (mm)	117	118	135	81	65	90	85	78	92	60	95	147
Run-off	70	71	81	48	39	54	51	47	55	36	57	88
Inlet (m^3)	1.109	1.119	1.280	763	616	853	806	739	867	569	896	1.394
Discharge	56.646	49.514	52.992	49.514	49.337	45.977	45.682	47.510	47.745	51.164	51.282	54.819
Average						**50.182**						
Eto	127	125	130	142	146	149	150	157	158	164	142	130
Eo	7.466	7.401	7.661	8.375	8.635	8.765	8.830	9.284	9.349	9.674	8.375	7.661
Storage	50.162	43.106	46.480	41.760	41.172	37.917	37.509	38.807	39.105	41.895	43.661	48.421
Net Vol	20.065	17.242	18.592	16.704	16.469	15.167	15.003	15.523	15.642	16.758	17.464	19.369
Usable Water	30.097	25.863	27.888	25.056	24.703	22.750	22.505	23.284	23.463	25.137	26.196	29.053
	Processing Realization 38,13 TBS, Water Requirement = 1,57 ton/TBS , Processing Hour 18 hour/Day Ccording to Production Table 2014 - 2020)											
Outlet m^3/Hari	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078
Availabe Water for Production	27.93	24.00	25.88	23.25	22.93	21.11	20.89	21.61	21.77	23.33	24.31	26.96
Avarage						**23,67 ~ 24,00**						

The table above shows the results of the calculation of the water balance, the results of the availability of water in the existing reservoir no. 4 is only able to meet the average production of 23,67 hours per day in a period of 1 year with production hours of 18 hours per day. This of course has not been able to sufficient the production target of 50 tons/FFB/hour, or 900 tons/FFB/day x 30 days = 27,000 tons of FFB/month.

Optimization of Reservoir Capacity

The planning concept used is the conservation of water resources by maintaining the water depth in accordance with the previous planning data, which is to form the bottom of the ponds back to its original depth which is 3 m. Thus, the deeper of pond bottom , the potential for groundwater utilization can be maximized. From the calculation results, the potential for groundwater discharge at the activity location varies after normalization. The largest groundwater discharge occurred in January is 282.483 m^3 while the smallest groundwater discharge occurred in June 136.685 m3 as shown in Table 3 below.

TABLE 3. Summary Calculation of Water Balance After Normalization in Pond 1,2,3, dan 4

Item/Month	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Ags	Sep	Okt	Nov	Des
Rainfall (mm)	117	118	135	81	65	90	85	78	92	60	95	147
Run-off	59	59	68	40	33	45	43	39	46	30	47	74
Inlet (m^3)	924	932	1.067	636	514	711	672	616	723	474	747	1.161
Discharge	282.483	233.884	235.403	182.247	164.782	136.685	141.241	164.782	182.247	235.403	250.590	282.483
Average						207.686						
Eto	127	125	130	142	146	149	150	157	158	164	142	130

Eo	7.466	7.401	7.661	8.375	8.635	8.765	8.830	9.284	9.349	9.674	8.375	7.661
Storage	275.815	227.290	228.679	174.366	156.514	128.483	132.934	155.957	173.463	226.039	242.820	275.854
Net Vol	110.326	90.916	91.471	69.747	62.606	51.393	53.174	62.383	69.385	90.416	97.128	110.342
Usable Water	165.489	136.374	137.207	104.620	93.909	77.090	79.760	93.574	104.078	135.624	145.692	165.512
Processing Targers Accordig to Operation 50 TBS, Water Requirement = 1,8 ton/TBS , Processing Hour 24 Hour												
Outlet (Irr) m3/Hari	2.160	2.160	2.160	2.160	2.160	2.160	2.160	2.160	2.160	2.160	2.160	2.160
Availabe Water for Production	76.62	63.14	63.52	48.44	43.48	35.69	36.93	43.32	48.18	62.79	67.45	76.63
Avalilable Water Production Before Normalization	28.00	24.00	26.00	24.00	23.00	22.00	21.00	22.00	22.00	24.00	25.00	27.00
Percentage Increase	173.63	163.07	144.31	101.81	89.03	62.23	75.84	96.92	119.02	161.62	169.80	183.80
Avarage Increse (%)						128.42						

The results of the above calculation show that normalization can increase the number of production days due to the availability of water volume that can be used for production by 173.63% from the number of days before normalization in January or an increase of 128,42% in the average number of annual production days. overall.

CONCLUSION

Based on the results of the study, calculations and data analysis in the research on optimizing the function of Ponds to meet the need of water supply at palm oil processing plant owned by PT, Perkebunan Nusantara VII (Persero) it can be concluded that the average utility consumption of water for processing palm oil into existing CPO is 1,73 tons of water/FFB, while for normal conditions it is 1.8 tons of water/FFB. The water needs are met from water sources originating from existing ponds, most of which comes from groundwater discharge and partly from surface runoff from rainwater. In locations, therea are 4 location ponds, but only pond no. 4 which is currently used as water supply of palm oil processing. The capacity at this location is only 50,428 m3 and its only able to sufficient the average production of 23.67 days per month. Thus, the production of CPO is not in line with the target for production capacity of 50 FFB/hours. Optimization of the existing 4 (four) reservoirs by returning the depth of the reservoir to 3 m resulted in an average holding capacity of 207.686 m3 or an increase of 413.86% from the current reservoir capacity. The calculation results show that normalization can increase the number of days of production due to the availability of the volume of water that can be used for production by 173,63% from the number of days before normalization in January or an increase of 128,42% in the average number of annual production days.

REFERENCES

1. Amril Ma'ruf Siregar. 2011. Maximizing the Design of Reservoir as a Source of Irrigation Water to Meet the Water Needs of Sugarcane Plants, Jurnal Rekayasa Vol 15, No.1 April 2011, Bandar Lampung
2. Bambang Triatmodjo. 2008. Hidrologi Terapan, Cetakan Kedua, Beta Offset Yogyakarta
3. Braja M Das. 2007. *Principles of Foundation Engineering 6th Edition, a divition of Thomson Canada Limited, Canada.*
4. Deacon C, Samways MJ, Pryke JS, 2018. Artificial reservoirs complement natural ponds to improve pondscape resilience in conservation corridors in a biodiversity hotspot. PLoS ONE 13(9): e0204148. https://doi.org/10.1371/journal.pone.0204148
5. D.W Norman. 1995. *Suistainable Dryland Cropping in relation to soil productivity – FAO soils Bulletin 72, The University of Queensland, Gatto, Australia*

6. Eka Sabria, 2011. Pengaruh Ukuran dan Kadar Prtikel Batang Sawit Terhadao Sifat dan Morfologi Material WPC Berbasis Limbah Batang Sawit, Prosiding SNTK Topi 2011 TMA04-18, ISSN 1907-0500, page 15-19
7. Herda Sabriyah, Kris RD Lulofs, Chay Asdak, Supli E Rahim, 2017. Strategies to Reduce Footprint in Palm Oil Production : A case of PTP Mitra Ogan, Baturaja, South Sumatera, Matec Web of Conference 97, 01122, DOI : 10.1051/matecconf/20179701122 ETIC 2016
8. Hill MJ, Ryves DB, White JC, Wood PJ, 2016. Macroinvertebrate diversity in urban and rural ponds, implication for freshwater biodiversity conservation, Biol Conserve 201 : 50-59
9. Eka Febria Sari, Zuansyah, Rimrawarman. 2011. Water Consumption and Potential Saving in CPO Process Sei Galuh Factory PT. Perkebunan Nusantara V, Prodising SNTK TOPI, ISSN. 1907-0500, Pekanbaru
10. Harto Br, Sri. 1993. Analisis Hidrologi. PT Gramedia Pustaka Utama : Jakarta.
11. Hary Christady H, 1994. Mekanika Tanah 2. Penerbit PT. Gramedia Pustaka Utama, Jakarta.
12. Imam Subarkah, 1978. Hidrologi untuk Perencanaan Bangunan Air. Idea Dharma, Bandung
13. Lembaga Penelitian Universitas Lampung, 2011. Revitalisasi Embung PT. Perkebunan Nusantara VII Unit Usaha Bunga Mayang, Bandar Lampung
14. K.K Wong, 1980. Application of Ponding System in the Treatment of Palm Oil Mill and Rubber Mill Effluents, Pertanika Vol.3 No. 2 page 133 – 141
15. PT.Perkebunan Nusantara VII (Persero), 2020. Laporan Hasil Produksi Tahunan Pengolahan Sawit Unit Usaha Bekri, Bandar Lampung
16. Bandar Lampung,RA Bustomi Rosadi, 2006. Pengaruh Defisit Evapotranspirasi dalam Regulated Deficit Irrigation (RDI) pada Kedelai (Glycine Max [L] Merr), Jurnal Keteknikan Pertanian Vol. 20 No. 1, https://doi.org/10.19028/jtep.02.0q.%25p
17. Triatmodjo, Bambang. 2008. Hidrologi Terapan. Beta Offset : Yogyakarta.
18. USAID Indonesia, 2019, Infiltration ponds: Restoring Groundwater Resources, Urban Water, Sanittation, And Hygiene Penyehatan Lingkungan untuk Semua (ILUWASH Plush), Jakarta
19. Ven te Chow, *Open Channel Hydraulic, International Student Edition, McGraw Hill Book Company, Inc, New York*
20. Sudjarwadi, 1987. Teknik Sumber Daya Air, Diktat Kuliah Jurusan Teknik Sipil, Yogyakarta.

2021
2nd ULICoSTE
UNIVERSITAS LAMPUNG INTERNATIONAL CONFERENCE ON SCIENCE, TECHNOLOGY AND ENVIRONMENT

CERTIFICATE

Number: 4602/UN26.21/PM.01/2021

This is to certify that

Amril Ma'ruf Siregar, ST, MT.

has participated as a **Presenter**

in the 2nd Universitas Lampung International Conference on Science, Technology and Environment (ULICoSTE) ***"Promoting Synergy through Collaborative Research in Science, Environment and Technology for Digital Transformation"*** held by the Institute of Research and Community Service Universitas Lampung August 27-28, 2021, Bandar Lampung, Indonesia.

Prof. Dr. Karomani, M.Si.
Rector

Dr. Ir. Lusmeilia Afriani, D.E.A.
Conference Chair

https://ulicoste.unila.ac.id/