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Prototype Of Soil Analyzer Devices Based On Long Range (LoRa) Communication System

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ABSTRACT

Problems of environmental damage caused by palm oil industry has become a global issue. This is often an obstacle to development of palm oil industry in Indonesia. In fact, millions of Indonesians work in palm oil sector and they are a source of state income from non-oil and gas. For this reason, efforts to support a sustainable palm oil industry need to be made. One of them is application of a smart system in palm oil industry. Soil analyzer tool is a smart system in palm oil industry. Rainfall, soil pH, temperature and humidity as well as lighting are environmental parameters that affect the growth and development of palm oil plants. Measurement results can be accessed and displayed in real-time based on LoRa technology. It is hoped that this soil analyzer will be a solution to environmental problems and related parties can determine mitigation actions in the most extreme conditions average of rainfall is 2.8 mm/day. Average of soil PH is 5.5. Average of light intensity is 10.146 lux. Average of temperature is 30.170C. Average of humidity is 70.57%.

1. Introduction

The palm oil commodity is increasingly showing its existence and it has become the backbone of the Indonesian economy. Exports of CPO and its derivatives reached 36.17 million tons in 2019. It increased 4.2% from exports in 2018. North Sumatra is one of the largest palm oil producers in Indonesia with plantation area expansion reaching 1.49% per year and each year is 1,260,080.95 ha.

Palm Oil plantations are spread across various districts in North Sumatra. Starting from the eastern tip of North Sumatra to the western end. These areas have a climate in accordance with the conditions for the growth and development of palm oil trees. Palm Oil plantations will also be developed to the southern of North Sumatra, especially in the districts of Padang Lawas, North Padang Lawas, and Mandailing Natal. These districts also have potential for palm oil development.

Availability of water for palm oil plantations is very important. Water acts as a means of transporting nutrients needed by plants and as a solvent for organic compounds from the soil to plant roots [1]. If the soil water content is reduced, it will impact to growth of palm oil plants. The stigma about palm oil as a "water greedy" plant is still growing in the community.

Various studies explain that the value of evapotranspiration or process of water loss in palm oil plantations is 1104.5 mm/year in Kalianta Kabun Riau [2]. The evapotranspiration value of peatland planted with palm oil in Seruyan Regency, Central Kalimantan is 386 mm/year [3]. The value of evapotranspiration in the Kapuas Landak palm oil plantation is 4.39 mm/day or equivalent to 1580 mm/year [4]. palm Oil trees need water 1500 - 1700 mm/year to meet the growth and production of palm oil fruit [5]. When compared with other tropical climate crops, the evapotranspiration value of oil palm is comparable to sugarcane 1000-1500 mm/year, banana 700-1700 mm/year and coconut 1980 mm/year [6].

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Evapotranspiration occurs in plants and soil. The average length of the radius of the plot of land shaded by oil palm trees is 250 cm. Then it can then be calculated how much water is needed for oil palm plants in liters. The following are the calculation steps.

a. Area of evapotranspiration
   $A=\pi r^2 = 3.14x250x250 = 196.250\ cm^2$
b. Water requirement
   0.410 – 0.465 cm/day [6]
c. Value of evapotranspiration
   $0.465x196.250 = 91.256\ cm^3/day = 91.256$ liters/day
d. Number of palm trees per ha
   140 trees
e. Water requirement per hectare of oil palm
   140x91,256 liters/day = 12,776 liters/day/ha

Another factor that affects the yield of palm oil production is pH level in the soil. Soil pH levels determine the activity of microorganisms in the soil. The activity of organisms will be low if soil pH is low [7]. Soil nutrients such as nitrogen, potassium, and phosphorus are also determined by soil pH levels. These nutrients are easily soluble in water so they are easily absorbed by plant roots [8]. Nutrients are needed by palm oil plants to increase the production of palm oil fresh fruit bunches [9]. Soil pH ideal level for palm oil trees is 5 – 5.5 [10]. Knowing pH level of soil will make it easier for palm oil farmers to determine type and dose of fertilizer so as to increase efficiency and reduce cost losses due to fertilizer wastage.

Based on these environmental parameters are rainfall, soil pH, temperature and humidity as well as sunlight that can affect the growth and development and production of palm oil plants. So, in this study it is necessary to study further to find out how to analyze these environmental parameters in order to know and observe soil conditions in palm oil plantations.

Information about environmental data must be able to be displayed and accessed in real-time via the internet via smartphones and computers. This is useful for determining policies related to mitigation when environmental conditions are in extreme conditions.

2. Research Method

The location of research was carried out at Telecommunications Laboratory of Politeknik Negeri Medan and in palm oil plantations at PTP 4 Pabatu. Parameters to be measured in this study are rainfall, soil pH, temperature and humidity and light intensity. Measured data must be compared with the national standard data set by the government for the requirements of palm oil plants growth.

This study was designed to be able to acquire data from the parameters that affect growth and development of palm oil plants. This tool will later be placed near palm oil trees. Figure 1 is an illustration of position of soil analyzer which is placed near an palm oil tree.

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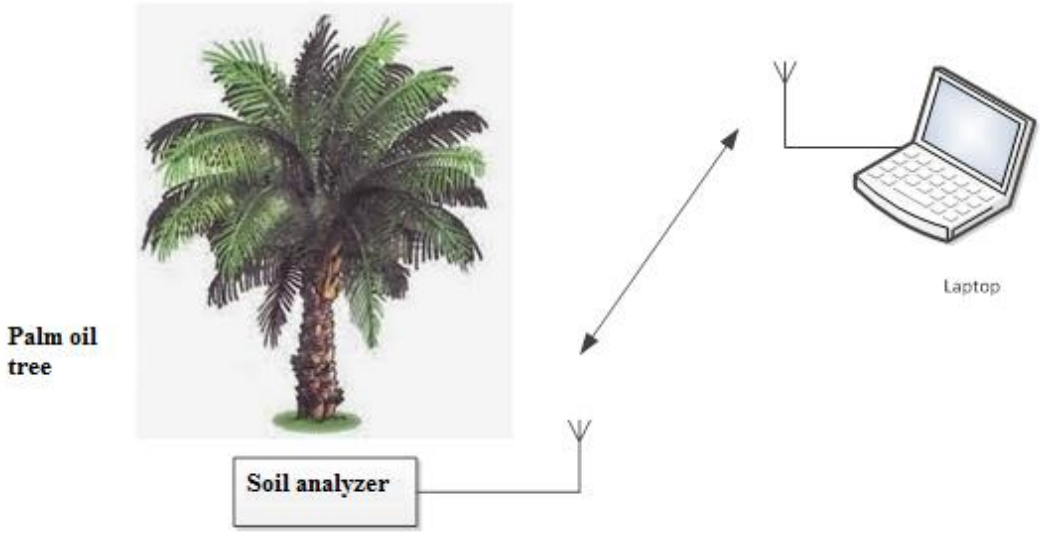

Fig 1. Ilustration of position soil analyzer

The research design is described in the form of a block diagram as shown in Figure 2. There are 5 main blocks, namely sensor block, analog digital converter (ADC) circuit block, microcontroller block, sending LoRa block and receiving LoRa block. In this design, an ADC circuit is needed to convert the measurement data that is still analog from the sensors. Furthermore, the sensor reading results will be sent from the sending LoRa to the receiving LoRa via LoRa communication system. Based on block diagram, circuit scheme will be designed next. Figure 3 is circuit schematic design.

Fig 2. Diagram block

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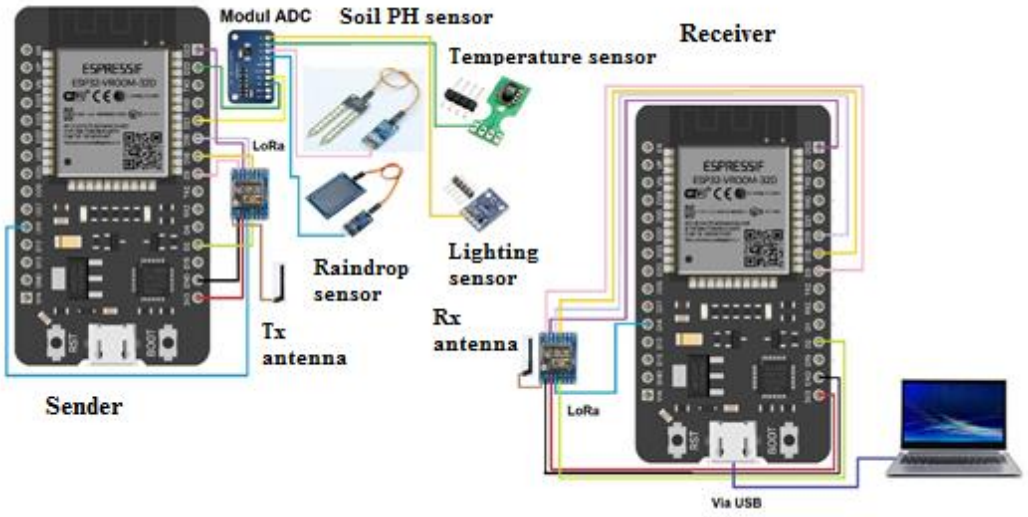

Fig 3. Circuit schematic design

The data collection and analysis of this system is divided into 2 parts, LoRa sender and LoRa receiver. On LoRa sender, there are LoRa parts, microcontroller ESP32, sensors. LoRa sender will send measurement data to LoRa receiver. There are LoRa parts, microcontroller ESP32 and laptop.

3. Result and Discussion

Table 1
Measured Data

Time	Parameters of Palm Oil Growth					
	Rainfall (mm/day)	Soil PH (0 - 14)	Lighting (lux)	Temperature (^{0}C)	Humidity (%RH)	Climate Status
2021-09-08 09.14	00.00	5.5	10,870	29.10	70.57	Partly cloudy
2021-09-08 09.28	00.00	5.5	11,100	29.11	70.43	Partly cloudy
2021-09-08 09.42	00.00	5.5	11,070	29.06	70.29	Partly cloudy
2021-09-08 09.56	00.00	5.5	11,030	29.15	70.37	Partly cloudy
2021-09-08 10.10	00.00	5.5	10,980	29.21	70.08	Partly cloudy
2021-09-08 10.24	00.00	5.5	10,890	29.24	70.12	Partly cloudy
2021-09-08 10.38	00.00	5.5	10,830	29.30	70.10	Partly cloudy
2021-09-08 10.52	00.00	5.5	10,730	29.33	70.17	Partly cloudy
2021-09-08 11.06	00.00	5.5	10,610	29.39	70.30	Partly cloudy
2021-09-08 11.20	00.00	5.5	10,590	29.52	70.61	Partly cloudy
2021-09-08 11.34	00.00	5.5	10,080	29.66	70.79	Partly cloudy
2021-09-08 11.48	00.00	5.5	9,730	29.65	70.08	Partly cloudy
2021-09-08 00.02	00.00	5.5	10,380	29.70	70.08	Partly cloudy
2021-09-08 00.16	00.00	5.5	10,500	29.69	70.88	Partly cloudy
2021-09-08 00.30	00.00	5.5	10,510	30.68	60.91	Partly cloudy
2021-09-08 00.44	00.00	5.5	10,660	31.67	56.71	Cloudy
2021-09-08 00.58	00.00	5.5	9,550	32.64	55.48	Cloudy
2021-09-08 01.12	00.00	5.5	9,400	32.65	55.38	Cloudy
2021-09-08 01.26	00.00	5.5	9,210	32.66	55.89	Cloudy
2021-09-08 01.40	00.00	5.5	9,080	32.70	55.56	Cloudy
2021-09-08 01.54	00.00	5.5	9,970	32.74	55.34	Cloudy
2021-09-08 02.08	00.00	5.5	9,720	32.74	55.05	Cloudy
2021-09-08 02.22	00.00	5.5	9,690	32.76	55.11	Cloudy
2021-09-08 02.36	00.00	5.5	9,620	32.79	55.11	Cloudy
2021-09-08 02.50	00.00	5.5	9,560	31.80	55.15	Cloudy
2021-09-08 03.04	00.00	5.5	9,570	31.86	58.42	Cloudy
2021-09-08 03.18	21.00	5.5	9,720	30.93	80.33	Rain

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Time	Parameters of Palm Oil Growth					
	Rainfall (mm/day)	Soil PH (0 - 14)	Lighting (lux)	Temperature (^{0}C)	Humidity (%RH)	Climate Status
2021-09-08 03.32	21.00	5.5	9,840	30.89	80.73	Rain
2021-09-08 03.46	22.00	5.5	9,850	30.01	80.31	Rain
2021-09-08 04.00	22.00	5.5	9,050	30.93	80.65	Rain
Average	**2.8**	**5.5**	**10,146**	**30.17**	**70.57**	
Conditions for growth and development of palm oil plants according to government standards 1. Soil pH: 4 - 6.5 2. Temperature : 24 - 29 ^{o}C 3. Humidity: 80 - 90% 4. Lighting : 5 - 7 hours/day 5. Rainfall : 4.10 – 4.65 mm/day						

Climate affects to growth of palm oil tree. They are air temperature, humidity, rainfall and light intensity. Research location is located around PTP IV Pabatu with 3°19′00″-3°21′00 ″ north latitude and 98°11′-98°21′ east longitude. This position affects to pattern of climate. Accosding to Table 1, average of rainfall is 2.8 mm/day. Average of soil PH is 5.5. Average of light intensity is 10.146 lux. Average of temperature is 30.17^{0}C. Average of humidity is 70.57%.

For soil PH and light intensity are normal according to palm oil plants standard. Soil PH is still range in 4-6.5 and sunlight is up to seven hours. There is fluctuation for temperature and humidity but it is not extreme. This value is still tolerable.

Associated with requirements palm oil plants growth, in terms of rainfall is below. According to BMKG data, monthly precipitation forecast during september 2021 in Pabatu around is 300-400 mm. It means water availability for palm oil plants growth is still fulfilled and suitable for palm oil needs. It is also supported by BMKG data about water availability for plants as shown in Figure 4. Water availability for plants base on territory is shown with 3 colors. Green color is sufficient. Yellow color is moderate. Red color is defisit. North Sumatera around is shown with green color. It means It's save.

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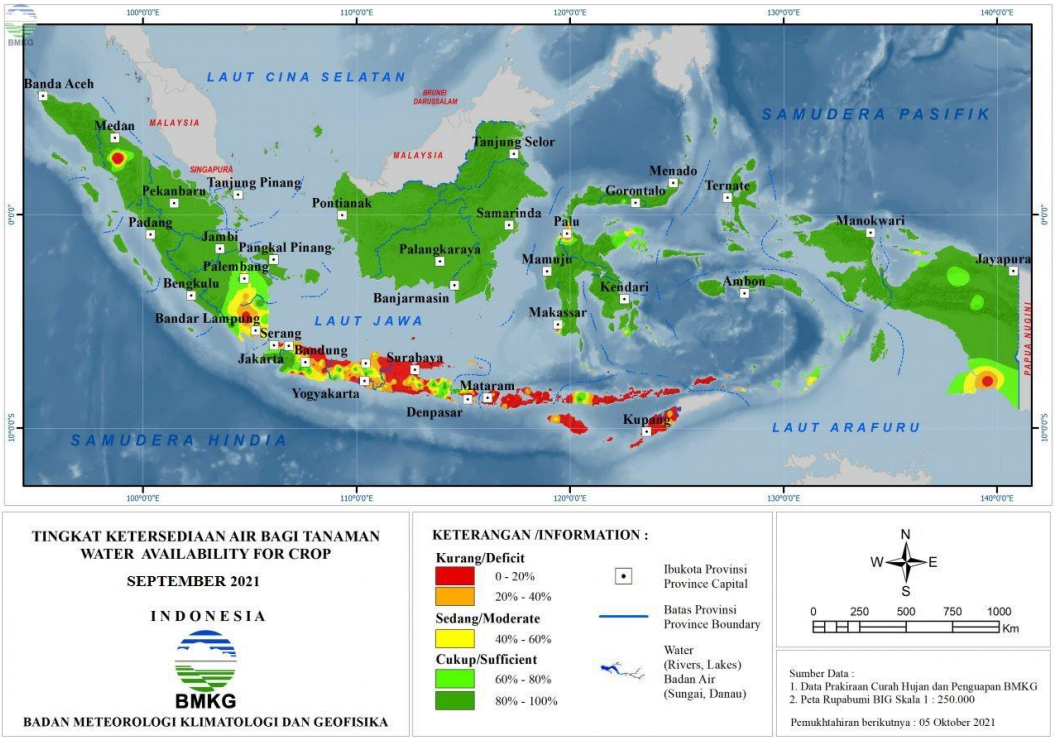

Fig 4. Water availability for plants

4. Conclusions

The climatic conditions in the SeiPagar oil palm plasma plantations are suitable for oil palm growth and production with an average annual rainfall of 2,339 mm yr-1, air temperature 26.4oC, and humidity 81.2%. 2. Soil erosion in the SeiPagar oil palm plasma plantation is low between 1,322-3,423 t hectare-1yr-1. 3. The type of soil in the Seipagar oil palm plasma plantation area is dominated by Typic Haplosaprists and Terric Haplosaprists with an area of about 8,641 hectares. The suitability of this soil belongs to the S2-f class (sufficiently in accordance with the high nutrient retention limit) related to low soil pH. Other soil types are Humic Dystrudepts and Typic Dystrudepts with an area of about 587 hectares. The suitability of this soil includes S2-f,n (sufficiently in accordance with the limits of high nutrient retention and low nutrient availability). 4. Soil chemical properties of Humic Dystrudepts and Typic Dystrudepts that affect oil palm FFB production are organic content, nitrogen content, P2O5 content and Stesedia content. In the soil types Typic Haplosaprists and Terric Haplosaprists, oil palm FFB production is influenced by organic C content, nitrogen content, available S content, and exchangeable aluminum content.

5. References

[1] F. B. Salisbury and C. W. Ross, "Fisiologi Tumbuhan," ITB. Bandung, 1997.
[2] H. Pasaribu, A. Mulyadi, and S. Tarumun, "Neraca air di perkebunan kelapa sawit di PPKS sub unit Kalianta Kabun Riau," Jurnal Ilmu Lingkungan, vol. 6, no. 2, pp. 99-113, 2012.
[3] S. D. Tarigan, "Neraca Air Lahan Gambut Yang Ditanami Kelapa Sawit di Kabupaten Seruyan, Kalimantan Tengah," Jurnal Ilmu Tanah dan Lingkungan, vol. 13, no. 1, pp. 14-20, 2011.
[4] M. Taufiq, H. Siswoyo, and W. Anggara, "Pengaruh tanaman kelapa sawit terhadap keseimbangan air hutan (studi kasus Sub das landak, das kapuas)," Jurnal Teknik Pengairan: Journal of Water Resources Engineering, vol. 4, no. 1, pp. 47-52, 2013.
[5] I. Harahap and W. Darmosarkoro, "Pendugaan kebutuhan air untuk pertumbuhan kelapa sawit di lapang dan aplikasinya dalam pengembangan sistem irigasi," Jurnal Penelitian Kelapa Sawit, vol. 7, no. 2, pp. 87-104, 1999.
[6] A. T. Maryani, "Pengaruh volume pemberian air terhadap pertumbuhan bibit kelapa sawit di pembibitan utama," Bioplantae, vol. 1, no. 2, pp. 64-74, 2012.

Accredited "Rank 4"(Sinta 4), DIKTI, No. 36/E/KPT/2019, December 13th 2019.

[7] S. Sabiham and B. Pramudya, "Analisis lingkungan biofisik lahan gambut pada perkebunan kelapa sawit," Jurnal Hidrolitan, 2010.
[8] S. Hardjowigeno, Ilmu tanah. Akademika Pressindo Jakarta, 2007.
[9] p. I. Di kebun kwala sawit, "kajian sifat fisik dan kimia tanah hubungannya dengan produksi kelapa sawit (elaeis guineensis, jacq)."
[10] I. Pahan, Panduan Teknis Budidaya Kelapa Sawit. Penebar Swadaya Grup, 2012.
[11] S. Espressif, "ESP32 Series Datasheet," Espressif Systems, pp. 20-50, 2019.
[12] H. Zhao, Z. Liu, G. Zhu, C. Shi, and Q. Xu, "A Flexible and Scalable Localization System for Off-the-Shelf LoRa Devices," in International Conference on Internet of Things as a Service, 2020, pp. 347-359: Springer.
[13] U. Mehboob, Q. Zaib, and C. Usama, "Survey of IoT Communication Protocols Techniques, Applications, and Issues," xFlow Research Inc, Pakistan, 2016.