

Development of light intensity data acquisition system to identify the suitability of soil conservation plants under the stand of cocoa trees

by Suhardi Suhardi

FILE	PAPER_DEVELOPMENT_OF_LIGHT_INTENSITY_DATA_ACQUISITION_SYSTEM.PDF (2.72M)		
TIME SUBMITTED	23-MAY-2019 06:58PM (UTC+0700)	WORD COUNT	1962
SUBMISSION ID	1134848461	CHARACTER COUNT	9804

PAPER • OPEN ACCESS

Development of light intensity data acquisition system to identify the suitability of soil conservation plants under the stand of Cocoa trees

To cite this article: Suhardi *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **235** 012090

2
View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the collection - download the first chapter of every title for free.

Development of light intensity data acquisition system to identify the suitability of soil conservation plants under the stand of Cocoa trees

Suhardi ¹, M T Sapsal ¹, and R Sjahrir²

¹Department of Agricultural Engineering, Hasanuddin University, Makassar 90245, Indonesia

²Department of Agronomy, Hasanuddin University, Makassar 90245,

E-mail: suhardi@unhas.ac.id

Abstract. One of the causes of the decline in cocoa productivity is the decreasing quality of land due to erosion. Application of conservation techniques to cocoa land are limited because this plant is an annual plant. One possible conservation technique is to conserve soil through vegetation. The problem in cultivating plants under tree stands is the lack of sunlight intensity because of the shade of canopy plants and protective plants. To determine the level of cover that is suitable for the growth of conservation plants, self-developed tools have been built to measure intensity of the sun light. The sensor used is the NHGH09BU Photosynthetic Active Radiation Sensor. This sensor connected to the Arduino UNO microcontroller module. The result of the test shows that this system can display a pattern of changes in the intensity of sunlight for 24 hours, where data above 300 W / m² reached at 10.00-14.30, and 0 W / m² at 16.50 - 7.20.

1. Introduction

The decrease in land productivity is due to a decrease in land quality that caused by erosion [1]. It is included in cocoa fields. In the tropics, surface flow plays a major role in erosion [2]. However, by doing soil and vegetation management can reduce it up to 99% [3]. The land cover is a basic element in erosion modeling [4].

To reduce erosion on cocoa fields, research on the application of conservation techniques using vegetation was conducted. However, the use of vegetation for conservation on cocoa fields has a limitation in the form of land cover by cacao plant canopy and protective plants so that the reception of sun intensity for conservation plants is limited. For this reason, the research was conducted to determine the conditions of cover that allow the growth of conservation plants under the pressure of cocoa plants and their protection. The appropriate closure is reviewed in real-time throughout the day. Considering that the required data is real-time data, while the widely available measuring instruments cannot provide data with these characteristics, the development of the Solar Light Intensity Data Acquisition System can be used to find suitable land cover conditions in the cultivation of soil conservation plants.



2. Methods

The implementation of this research includes system design, hardware design, software design, and tool performance testing. This system is installed in the cocoa plantation land located in Bone Regency.

2.1. System design

This data acquisition system records Photosynthetically Active Radiation (PAR) data. PAR measurement in plant science aims to explain radiation quantitatively as the driving force behind photosynthesis. PAR is a part of the electromagnetic radiation that can be used as an energy source for photosynthesis by green plants. To facilitate the calculation and measurement, the wavelength is set at 400 - 700 nm PAR by ignoring the contribution of photosynthesis at wavelengths below 400 nm and above the relatively small 700 nm [5].

Data read by PAR sensors are processed by a microcontroller, analog data in the form of voltages derived from sensors are converted to digital values. The digital value is converted to PAR value in units of W / m^2 . To determine changes in PAR values, the data is recorded every minute. The data in the recording is in the form of date, hour, minute and PAR value, for that time counting system is needed which is able to provide real time data. Besides being stored in memory, the data can also be viewed at any time using the display. The picture below is an overall system block diagram of tool design:

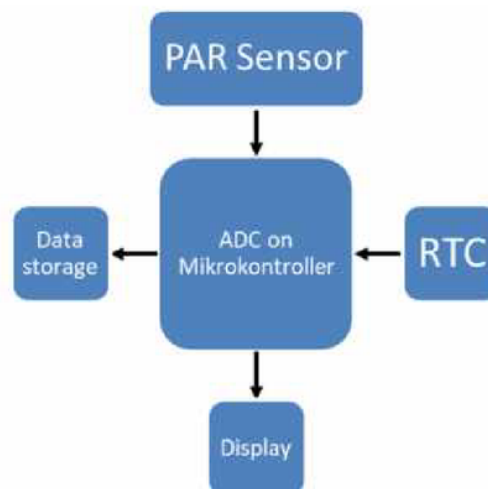


Figure 1. Block diagram of data acquisition system for solar light intensity

2.2. Hardware design

Hardware to meet the needs as described previously consists of DS 1302 RTC module as a time counter to produce time according to the calendar system that occurs at the location. This module has an I2C communication path so that communication can save the use of pins in the microcontroller module. The micro SD module is used as a recording device and reader of data stored in micro SD. PAR sensors used were calibrated NHGH09BU with a sensitivity of $2 \text{ mV} / W / m^2$ with an error rate of 5% and a voltage range of 0 - 2 V. use of the microcontroller from the AVR ATmega family because of its reliability and speed of executing commands. This microcontroller has been widely used in the development of sensors, one of which is to detect groundwater content in cocoa fields [6] and produce a fairly accurate reading. As a source of power, this system is powered using a dry battery of 12V 7AH and is protected by water repellent materials.

2.3. Software design

Software design using C language. The program is designed in a computer, using the Arduino IDE 1.8.7 software, where the program gives an order that the A1 pin on the Arduino UNO module is functioned as an ADC (Analog to Digital Converter) 10 bits. In addition to collecting the recording time, Module RTC DS 1302 communicates using I2C and data retrieval is done every 1 minute. Then the data is stored on the memory card and also displayed via the LCD. PAR sensors are connected to the Arduino UNO ADC pin, based on the ADC resolution used and the sensor sensitivity value where the reference voltage is 5 V, then to convert the ADC value to PAR value using the equation:

$$\text{PAR} = 4.89 * \text{ADC} \quad (1)$$

This system is made so that after the data recording process is complete or when data is needed, data can be retrieved directly without stopping the recording process. Therefore the Arduino module can be connected via serial communication with the RS232 protocol to the computer, so that the memory card does not need to be revoked, only by sending reading commands via serial communication to the Arduino UNO module.

2.4. Performance test

The performance test includes testing the function of each module about the suitability of the design results, as well as testing the performance of data recording. This system is placed under the auspices of cacao trees (figure 2) and left for two weeks. The ability of the system to acquire light intensity data is recorded every minute in 24 hours until the power on the battery runs out. A new battery is then installed to retrieve data that has been recorded without the need to unplug the memory card. Recorded data and recording time are observed to find out if there is data lost at a certain time, both during the recording process, and when data collection. Furthermore, the sun light intensity data is plotted into the graph to determine the distribution pattern of light intensity in 24 hours recorded by this system.



Figure 2. Installation of the solar light intensity data acquisition system on site

3. Results and Discussion

Tool testing is carried out in three different land cover conditions using three tools. This is intended to see the consistency of data recording carried out by the three tools. Consistency is seen based on the occurrence of differences in readings due to differences in land cover, but with a similar reading range because the tests were carried out at the same location.

The test results show that the recording performance of the measuring instrument in good category with the following indicators: able to record every minute without losing data, able to record for 5 days with recording every minute, resistant to water, responsive to changes in land cover conditions,

stable (no oscillation) and sensitive with a reading of one hundred values of sunlight intensity. The following are the results of testing tools:

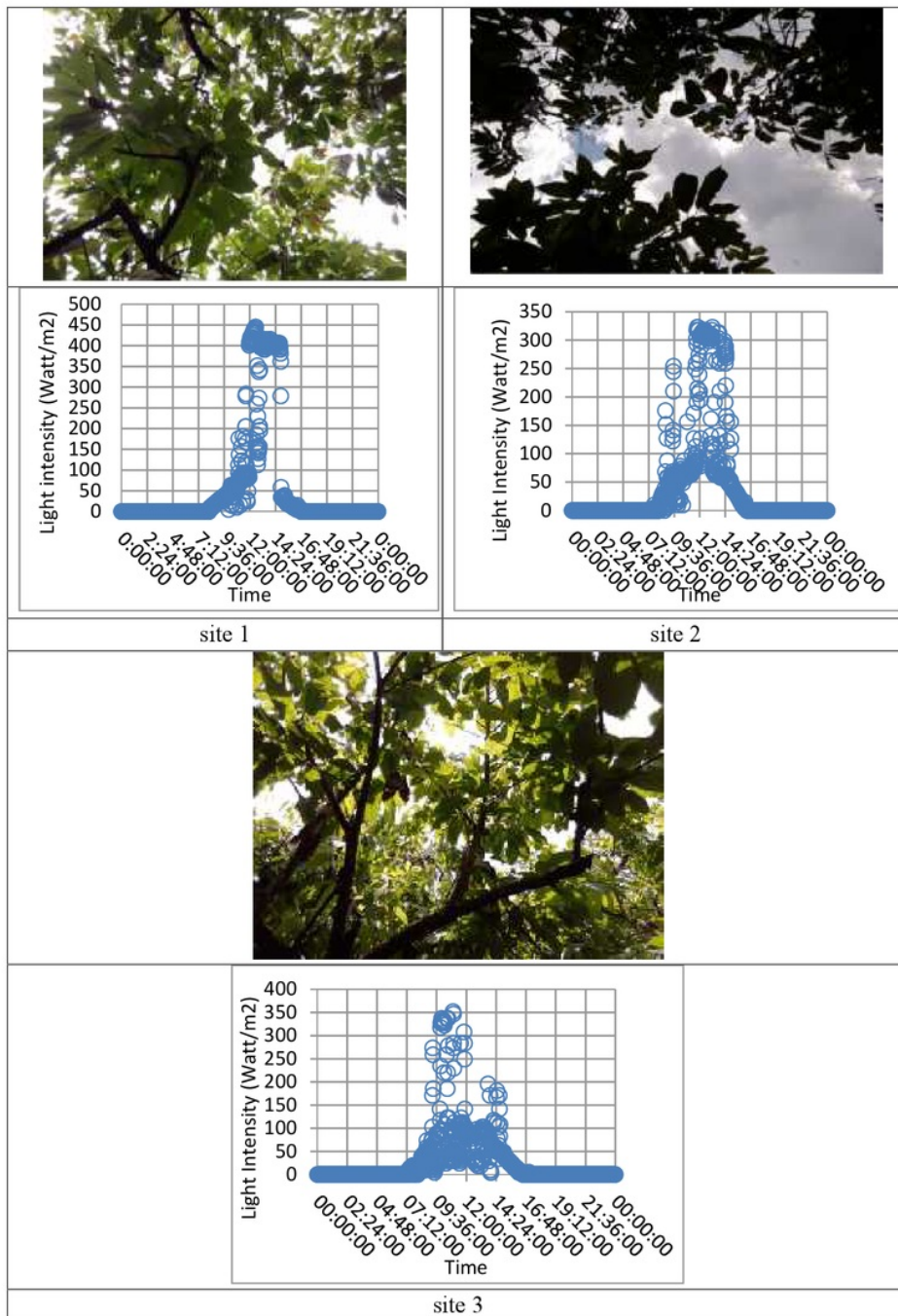


Figure 3. Conditions of land cover and changes in solar radiation

The picture above shows that in evenly distributed land cover, the sun's exposure to the land is generally below 150 Watt / m² (point 3), while if the land cover is open enough, the intensity above 150Watt / m² is more dominant (point 2) , while if there is a gap that is just above the tool, there will be a maximum irradiation intensity that is above 400 Watts / m² (point 1). This shows that the sun intensity measuring instrument has a good performance.

4. Conclusion

The data acquisition system has been successfully created and can record data in every minute. This system can display the pattern of changes in sunlight intensity for 24 hours. Data reading of sunlight intensity obtained under the shade of cocoa land is able to reach 400 W / m².

Acknowledgment

Our gratitude goes to DP2M Dikti for the assistance of research funds given to us through the PDUPT Scheme in 2018 with Contract No. 123 / SP2H / PTNBH / DRPM / 2018 entitled: Vegetative Conservation as an Effort to Improve Cocoa Land Quality.

References

- [1] Li Z, Huang J, Zeng G , Nie X, Ma W, Yu W, Guo W and Zhang J 2013 Effect of erosion on productivity in subtropical red soil hilly region: a multi-scale spatio-temporal study by simulated rainfall *PLoS ONE* **8**(10) e77838
- [2] Suhardi, Munir A, Faridah S Nur, Prawitosari T and Palimbu S 2017 Effect of land management models on soil erosion in wet tropical cacao plantations in Indonesia *Eco. Env. & Cons.* **23** (2) 1085-92
- [3] Labrière N, Locatelli B, Laumonier Y, Freycon V and Bernoux M 2015 Soil erosion in the humid tropics: A systematic quantitative review *Agriculture, Ecosystems and Environment* **203** (2015) 127–39
- [4] Ekpenyong R Etim 2013 An assessment of land cover change and erosion risk in akwaibom state of nigeri using the co-ordination of information on the environment (corine) methodology *Greener Journal of Physical Science* **3** (3) 76-89
- [5] Möttus M, Sulev M, Baret F, Lozano R Lopez, Reinarg A 2011 *Photosynthetically Active Radiation: Measurement and Modeling* (New York: Springer)
- [6] Sapsal M Tahir, Suhardi, Munir A and Hotabara O Sanny 2014 *Prosiding Seminar dan Lokakarya Nasional FKPT-TPI 2014* (Pekanbaru :Universitas Riau) p 310 - 317

Development of light intensity data acquisition system to identify the suitability of soil conservation plants under the stand of cocoa trees

ORIGINALITY REPORT

% **4**

SIMILARITY INDEX

% **2**

INTERNET SOURCES

% **1**

PUBLICATIONS

% **0**

STUDENT PAPERS

PRIMARY SOURCES

1

Jäger-Waldau, Arnulf. "Photovoltaics photovoltaic (PV) , Status of", Solar energy, 2013.

Publication

% **1**

2

dro.dur.ac.uk

Internet Source

% **1**

3

businessdocbox.com

Internet Source

% **1**

4

repository.unhas.ac.id

Internet Source

% **1**

5

edoc.site

Internet Source

<% **1**

EXCLUDE QUOTES ON

EXCLUDE ON

BIBLIOGRAPHY

EXCLUDE MATCHES

< 5

WORDS