Rainfall Meter Using Arduino and AquaPlumb Water Level Sensor

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Abstract. Rainfall data is one component that is widely used in research related to hydrology. Including in implementation of zero run-off system on cocoa land. However, the current source of rainfall data is sometimes incomplete. For that it is needed a rain gauge that is able to provide real-time measurements at certain locations. This tool was developed using the AquaPlumb® water level sensor. Testing is done by measuring the water level in a 2-inch pipe. The sensor is able to detect changes in surface height with a coefficient of determination of more than 98%.

1. Introduction

The decrease in watershed performance can be seen from an indication of an increase in the ratio of maximum discharge to minimal discharge due to large surface runoff during rain [1]. High surface runoff can cause erosion. On land that has been converted from forests to plantations, such as cocoa, resulting in an increase in erosion up to 1916.5% in young cocoa fields [2].

Efforts can be made to reduce erosion by reducing surface runoff and increasing ground water recharge. Implementing a zero run-off system is one way that can be done. This technology can reduce the occurrence of surface runoff by inserting surface runoff into the ground as ground water recharge. This system is in the form of a well that built where the surface water flow. The dimensions of the building are determined using a mass conservation approach. The mass of water entering the system is the same as the exit. The incoming water mass is a function of land characteristics (slope and vegetation conditions) and climate (rainfall), while the outflow that is groundwater recharge is a function of the wet area of the ZRO system and hydraulic conductivity of soil.

Rainfall is one of the most important data for designing a ZRO system. While rainfall data so far are secondary data, sometimes the data are incomplete. Therefore rainfall data on research of the implementation of zero run off on cocoa land conducted in Bone Regency is measured using manual equipment whose data is not real-time.
Rainfall data is measured every two days by storing water in a container then the water level is measured using a measuring cup. Weaknesses of this method include when transferring from a container to a measuring cup which sometimes spills or requires energy to move it, another thing that happens is if it rains with a very high intensity so that the water reservoirs are full and cause actual rainfall to not be measured / measurement is not right, another problem is the unknown relationship between rainfall and ZRO system performance in real-time. Therefore, it is necessary to develop a tool that is able to measure rainfall in real-time.

2. Method

The development of tools is planned in order to achieve the desired goal to create a tool that is capable of recording rainfall. The design includes the system, hardware and software accompanied by testing.

2.1. System design

This measurement tool records rainfall in the study area by measuring the height of the water surface in the rainwater reservoir. The change in water level is read by a sensor with an analog data output (voltage), then the data is converted to digital data by a microcontroller. Events of changes in water level in the container are acquired together with the time of occurrence. The data obtained are stored in a data recording system with a data retrieval duration every 1 minute. Besides that, data can also be seen directly through the available display. System block diagram as shown as figure 2.
2.2. Hardware design

Components needed so that the system is made according to the design, as described previously, consists of a water level sensor in the form of AquaPlumb® Water Level Sensor with an output range of 0 - 3 V and a resolution of 1 mm for a sensor with a length of 1 m, this sensor requires a low power consumption (1.2 mA) so suitable for remote data recording systems. This sensor consists of a piece of wire which is insulated so that it does not in direct contact with water. Water reservoir in the form of a pipe with a diameter of 5.08 cm (2 inches) and a height of 80 cm. To obtain time data using the DS 1302 RTC module, data storage uses a micro SD module. To display data while in the field can be seen through a 20 x 4 LCD module. Data processing using Arduino MEGA 2560 microcontroller that uses AVR-based ATmega2560 chip. AVR-based microcontroller often used for both control systems and data logging systems, one of which is to detect solar light intensity under cocoa plant coverage [3] and provide information about 24 hours trend of sunlight intensity. To power the whole system using a dry battery with a capacity of 7 AH and 12V voltage. The tool will be stored in an open area so it needs protection against water using water repellent materials.

2.3. Software design

Command line code is created using C language through Arduino IDE 1.8.9. The sensor is attached to pin A0 on Arduino which is an ADC (Analog to Digital Converter) pin with a resolution of 10 bits (0 - 1023). When collecting water level data, information on data collection time is also taken using Module RTC DS 1302 through I2C communication. Data collected every minutes then stored on a data storage through the SD card module. Besides that the data is also displayed via the LCD. Analog data of water level in the form of voltage are converted in digital values in the range 0 - 1023, the data is then converted to water level

2.4. Testing

The Performance of tools that developed in this activity tested specially for the accuracy of the water level. The data will then be converted into rainfall data. The test is done by filling the water reservoir pipe and measuring the surface height that is read by the tool and comparing it to the actual height. The actual height is obtained from a transparent hose connected to the storage container, the test illustration can be seen in the following image:

![Illustration measurement test by sensor](image)

Figure 3. Illustration measurement test by sensor

3. Result and Discussion

The test was carried out on a surface height of 6-70 cm. The results obtained showed that the sensor used was able to provide a response to changes in water level in a container with good sensitivity with a coefficient of determination 99% and expressed as y = 5.736x + 107,75.
Figure 4. Changes in ADC values to changes in level of water

The ADC value changes linearly with a value proportional to the change in water level in the pipe. The sensor used is an isolated wire, where the wire is not directly related to water. So that the sensor reading value is consistent in a long time of use. Because there is no concern about the influence of rusting sensors, or the influence of pH and salt. Generally, surface water level sensors use sensors that do not come into direct contact with water to avoid corrosion problems, for example by using ultrasonic sensors (proximity sensors), but the use of these types of sensors requires moving parts in the form of a float [4] which certainly requires a special design so that the float remains can move according to water level. Another sensor that is often used that is related to water is the use of the concept of conductance using plates or electrons which are given an electric potential difference, generally in the form of sinusoidal signals [5], but this method needs to consider the corrosion resistant material factor in long-term use [6].

The relationship data between the ADC values with the water level obtained is used to measure the water level. Adjustments were made at ADC value <108, so the height was 0 cm. The following results are the comparison between measurements read by actual measurements:

Figure 5. Comparison between actual measurements and sensor

The picture above shows that the tool developed is able to measure changes in water level in the pipeline accurately where the coefficient of determination more than 99%. To state this information in rainwater volume, the pipe diameter is converted to 1 meter² multiplied by the water level in the pipe (in m)
4. Conclusion
Rainfall measuring instrument that was developed is able to detect changes in water surface height accurately

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References
[1] Suhardi, Munir A, Sapsal MT, Faridah SN and Samsuar 2019 Implementation of zero run-off system on cocoa land to increase watershed performance IOP Conf. Ser.: Earth Environ. Sci. 235 012089
[2] Hidayat Y, Sinukahan N, Pawitan H and Tarigan S D 2007 Dampak perambahan hutan taman nasional lore lindu terhadap fungsi hidrologi dan beban erosi (studi kasus daerah aliran sungai nopu hulu, sulawesi tengah) Jurnal Ilmu Pertanian Indonesia. 12(2) 84-92
[3] Suhardi, Sapsal MT and Sjahri R 2019 Development of light intensity data acquisition system to identify the suitability of soil conservation plants under the stand of cocoa trees IOP Conf. Ser.: Earth Environ. Sci. 235 012090
[4] Sulistyowati R, Sujono HA and Musthofa AK 2015 Sistem pendeteksi banjir berbasis sensor ultrasonik dan mikrokontroler dengan media komunikasi sms gate way Seminar Nasional Sains dan Teknologi Terapan III (Surabaya : Institut Teknologi Adhi Tama) p 45-98
[5] Martani M and Endarko 2014 Perancangan dan pembuatan sensor tds pada proses pengendapan CaCo3 dalam air dengan metode peluatan elektron dan medan magnet Berkala Fisika. 17(3) 99 – 108
[6] Hermawan B 2005 Monitoring kadar air tanah melalui pengukuran sifat dielektrik pada lahan jagung monitoring soil water content using dielectrical properties at corn field Jurnal Ilmu-Ilmu Pertanian Indonesia 7(1) 15 -22