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Analysis of Rainfall from Tipping bucket raingague

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Abstract: Rain transfers water from the sky to the surface, sustaining life. To understand the water cycle, monitor and forecast local and worldwide rainfall behaviour. Mostly agricultural engineers, construction engineers seek catchment area precipitation and water capacity. Install a rain gauge and analyse data. A tipping bucket rain gauge is the most efficient, accurate, and cost-effective rain gauge. The tipping bucket rain gauge with GPRS-based data logger DL-2016 was used for this project to store data longer. All industry, irrigation, drinking, and towns need rain. We choose a rain gauge to gather yearly data and install it at ABR College. Collect rain gauge data to analyse and calibrate precipitation. Calibration and analysis are done via hydrographs. Draw hydrograph to gather precipitation data in the ABR college catchment, we installed a tipping bucket rain gauge on the top floor and followed data logger requirements to track precipitation intensity over time of Dec-2023, Jan-2024. We can analyse precipitation in the ABR college catchment region using this data.

***Index Terms* - Tipping bucket rain gauge, DL-2016 GPRS data logger, Analysis, hydrographs, ABR college, Hypertrm software.**

I. Introduction

The whole of this work is devoted to the specification, installation, and analysis of data pertaining to precipitation. The specs included information on an automated rain gauge (also known as a Tipping bucket rain gauge) and a datalogger [1]. The purpose of an automatic rain gauge is to record continuous data of a high quality about the length, intensity, and total quantity of precipitation episodes [2]. There are hydrologic processes that are responsible for precipitation, and it is vital to have a full understanding of the precipitation regime.

conducting hydrologic response assessments and making predictions. In addition, information on precipitation is used extensively in the fields of civil engineering, water resource engineering, hydrology, agricultural engineering, irrigation engineering, and many others [3]. This continuous data of precipitation is stored in the storage that is considered definitive. A connection is being made between the tipping bucket rain gauge and the output of the datalogger in order to display the instantaneous intensity of the precipitation, and the datalogger is storing the total amount of precipitation in duration over time [4]. The connection and bucket that were returned during the rain made it possible to determine the amount of precipitation that occurred during any given time period [5,6]. The patterns of rainfall that occur during storms often exhibit a random cellular structure. This structure may be represented using spatial and temporal correlation functions that are computed from short-interval precipitation observations. The British Meteorological Office was responsible for the operation of a network of sixteen rain gauges at Cardington during the years 1957 and 1962 [7,8]. The gauges were spaced roughly four km apart. Throughout a series of storms that occurred mostly throughout the summer, the gauges were used to monitor the quantity of rain that fell at intervals of two minutes. The techniques that were established for the investigation of moving diffraction patterns that were formed by radio sounding the ionosphere have been applied to this data [9,10]. The datalogger was first used for the purpose of gathering the rates of precipitation strength and the resolution of the rain gauge, along with any modifications that occurred in the standard from one minute to the next for any kind of rain, including severe rain as well [11,12].

This tipping bucket rain gauge, known as the ARG100, is a well-designed instrument that combines a sturdy construction with a cost that is extremely fair. Given that the gauge provides less resistance to airflow than the majority of the designs that came before it, it helps to lessen the sample mistakes that are obviously going to occur when wind-driven rain is occurring. The gauge is produced by Environmental Measurements Ltd. for Campbell Scientific Canada (Corp.) (under licence from the Institute of Hydrology), and it offers dependable functioning for a significant number of years when it is installed and positioned with great care [13,14].

For the purpose of determining the geographic size of the pattern, its velocity, and its mean lifespan, the temporal variations in rainfall that were recorded at three gauges that were appropriately separated were used. This approach has been applied to a number of different sets of gauge recordings which were collected during an abnormally high storm, and it has shown a high degree of agreement with the upper-air data that is pertinent [15,16].

The sampling-related errors of tipping-bucket (TB) rain gauge readings, with a particular emphasis on the gauge's capacity to capture the temporal variability of rainfall on a small scale. A straightforward TB simulator was used by us, and it made use of observations obtained from an experimental optical rain gauge with an extremely high resolution. In order to obtain estimates of the TB rain rate on time scales as short as one minute, the simulated observations were employed.

The findings of the simulation demonstrated that the estimations of TB are subject to large inaccuracies if they are based on time scales that are smaller than ten to fifteen minutes.

The rough formulae that are used to characterise the TB sampling mistakes at a number of different time scales are presented here that we have. Our findings highlight the significance of using the high precision of both the sample time interval and the bucket size in order to ensure that the estimations of the TB rain rate have the least amount of uncertainty possible [17].

One of the most efficient, precise, and cost-effective rain gauges is the tipping bucket. A tipping bucket rain gauge with GPRS-based data logger DL-2016 was chosen for storing data with dates.

The block was built above the fourth level, 0.6 metres from the parapet wall, using brick measurements. The block has dimensions of 0.46 * 0.46 m2 and a height of 1 m. We constructed a 6-inch concrete bed with M-30 grade concrete on the block. Two 0.08 * 0.45 m2 wooden blocks were put on the concrete bed with a 0.01 cm spacing between them and a rain gauge positioned on the woodblock. Installed the rain gauge instrument using levelling materials and created slopes between two wooden blocks to allow water to flow down from the bucket. A wooden block with four corner screws holds the rain gauge, which must follow the flow direction below the buckets. After constructing the block and installing the rain gauge, connect a data logger with an extra cable for power. Not allowed to set data logger in rain.

Maintain a safe, moisture-free location near the electrical connection. Hypertrm programme retrieves precipitation records from GPRS-based datalogger DL-2016, calculates precipitation at 1hr (mm/h), and calculates discharge by multiplying catchment area (km2). Refer to the table below for precipitation data for hydrographs. Extreme precipitation scenarios are utilised to create design storms, including the hydrograph of excess precipitation generating floods. The catchment unit hydrograph is used by the design storm to create the required flood hydrograph. Peak discharge = 28.89 m3/s, Maximum flood discharge: Qp = 31.56 m3/s. The unit hydrograph approach predicts peak flood hydrographs based on rainfall, watershed infiltration parameters, and existing unit hydrographs. Extreme rainfall circumstances are utilised to create design storms, including the hydrograph of excess rainfall generating floods. The catchment unit hydrograph is used by the design storm to create the required flood hydrograph [18].

In this paper, main objective is draw hydrograph to gather precipitation data in the ABR college catchment, we installed a tipping bucket rain gauge on the top floor and followed data logger requirements to track precipitation intensity over time of Dec-2023, Jan 2024. We can analyse precipitation in the ABR college catchment region using this data.

II. Describe the Dl-2016 rain gauge and GPRS-based datalogger specifications:

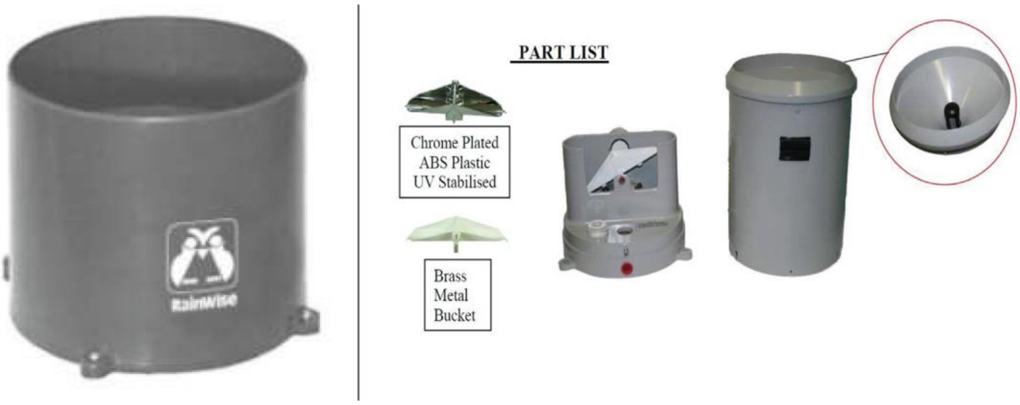

Fig. 1Tipping bucket rain gauge [18]

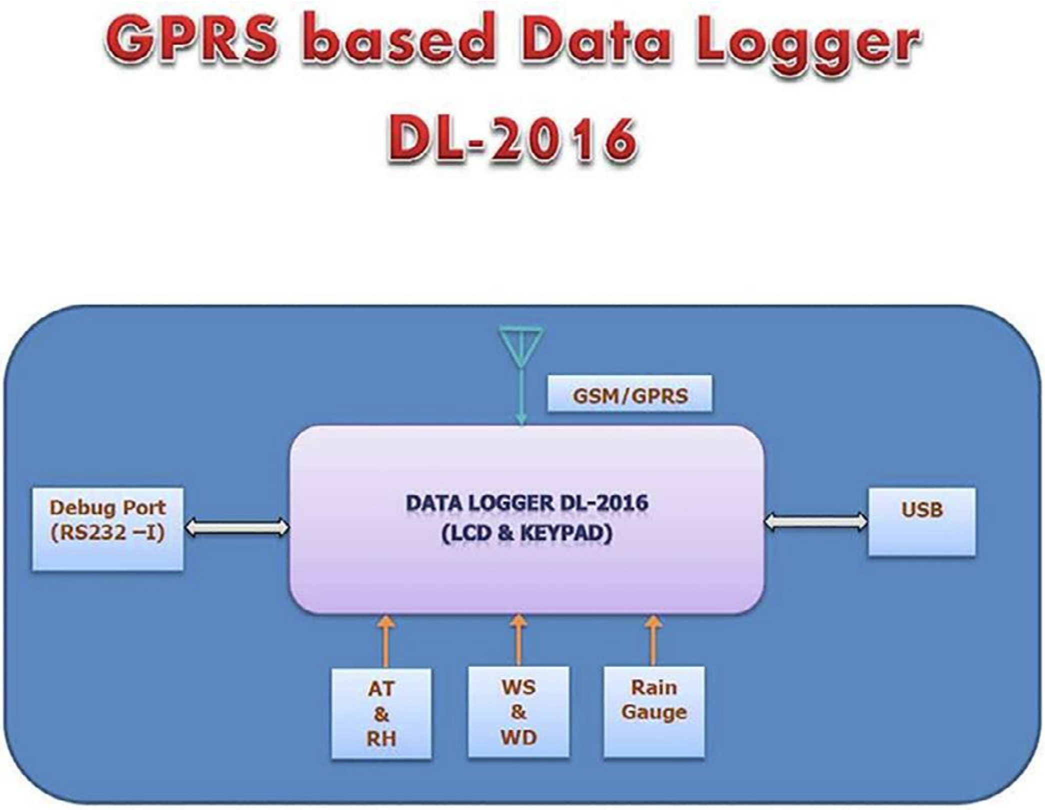

Fig.2 Working condition of Data Logger [18]

The tipping bucket rain gauge, also known as Rain Wise RENEW Industrial, was designed to give precise data collection about precipitation. Fig. 1 depicts the rain gauge, and the following is a description of the rain gauge's specifications [18]. There is a brief explanation of the tipping bucket given. The rain wise tipping bucket rain gauge is seen in Figure 1, along with a list of its components. The functioning of the rain gauge: It is possible to measure the intensity of the precipitation in terms of the duration over time. It is capable of functioning in any kind of weather, even severe rain, and it can do so continuously.

Details on the TAGV-DL2016 data logger specifications: According to [18], the TAGV-DL2016 Event Logger is a tiny datalogger DL-2016 that is based on GPRS and records data on precipitation. The operating state of the GPRS-based data logger DL-2016 is shown in Figure 2. The schematic that is provided with the components includes the processing system, connectors, analogue inputs (AI), digital inputs (DI), and GPRS information of the datalogger.

III. Installation, Data and analysis:

The site must fulfil these requirements for rain gauge installation: Need slope-free ground. The site should avoid heavy winds. Avoid obstacles like trees and highrises. Minimum clearances should be 1.5 times significant obstructions. Bricks were used to build the block above the fourth level, 0.6 m from the parapet wall. Block measurements are 0.46 m2 x 0.46 m2 and height is 1m. A 6-inch M-grade concrete bed was built on the block. Two 0.08 * 0.45 m2 wooden blocks with a 0.01 cm spacing between them and a rain gauge were placed on the concrete substrate. Level the rain gauge and make slopes between wooden blocks to let water flow from the bucket. A wooden block with four corner screws holds the rain gauge, which faces the bucket flow. After creating the block and adding the rain gauge, power a data logger with an additional cable as it cannot be submerged. Store near electricity and away from dampness. Finally, verify rain gauge connections and levels. The GPRS-based datalogger DL-2016 provides precipitation data to Hypertrm: A PC is required to transfer data from DL-2016 GPRS dataloggers on site. Port the GPRS-based datalogger DL-2016 to the PC using the interface cable. Use DL-2016 GPRS datalogger with Hypertrm. After installing Hypertrm and SilLabs, display programme icons and find the analysis icon. Right-clicking the symbol opens a dialogue box with connection details, including location and job info. Click OK after entering ABRCET. Following screen requests location, area code, phone number, and connection (COM1, COM3). Following "OK," COM3 properties such Bits per second, Data bits, Parity, stop bits, and Flow control will appear. Select Displays, then Restore Defaults. GPRS-based datalogger DL-2016 precipitation data appears in a dialogue window when you click "Ok". Paste data into Excel to build hydrographs, predict peak floods, and track precipitation. GPRS-based datalogger DL-2016 measures precipitation at 1hr (mm/hr) and calculates discharge by multiplying catchment area (km2). Drawing hydrographs using precipitation data. Data from the data logger is tabulated according to discharge time. from two consecutive values in order discharges. A D-h unit hydrograph causes this S-curve. A steep starting part leads to a maximum equilibrium discharge at the same time as the first unit hydrograph. The S-curve is produced by an average intensity of ER of 1/D cm/h and an equilibrium discharge. A is km2 and D is in h. Qs is the maximum pace at which 1/D cm/h of ER intensity may drain from a catchment in area A. The development of an S-curve revealed that the top section oscillates around the equilibrium value owing to hydrograph magnification and tiny mistakes [18].

$$Qs = 2.778*(10/1) = 27.78 \text{ m3 /s}$$

$$\text{Assume } A = 10 \text{ km2 } D = 1\text{hr}$$

$$Qs = 2.778\ (A/D) \text{ m3 /s}$$

IV. Analysis rainfall data stored data from GPRS based datalogger using S-hydrograph

Data from the data logger is tabulated according to discharge time. Peak discharge =0.51m3/sec, values shows in figure 3, same two consecutive discharge readings on 05-12-2023.

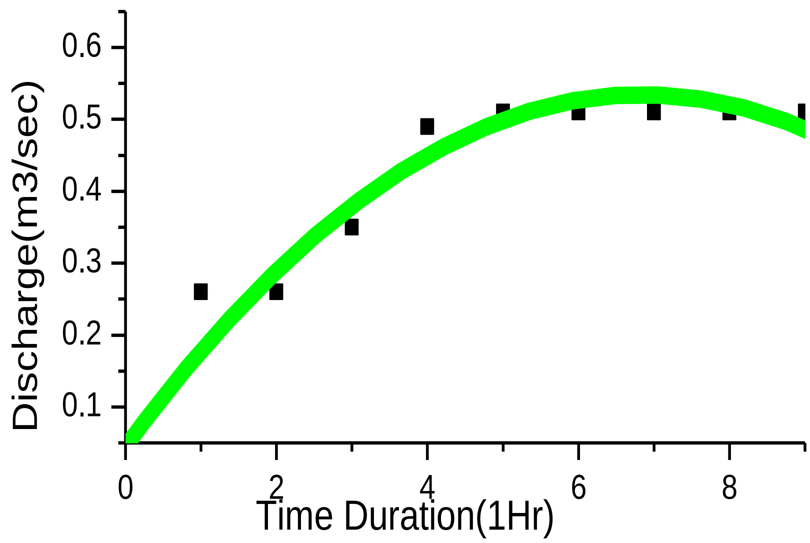

Fig. 3 Discharge vrs Time on 05-12-2023

Peak discharge =7.6m3/sec, values shows in figure 4, same two consecutive discharge readings on 06-12-2023.

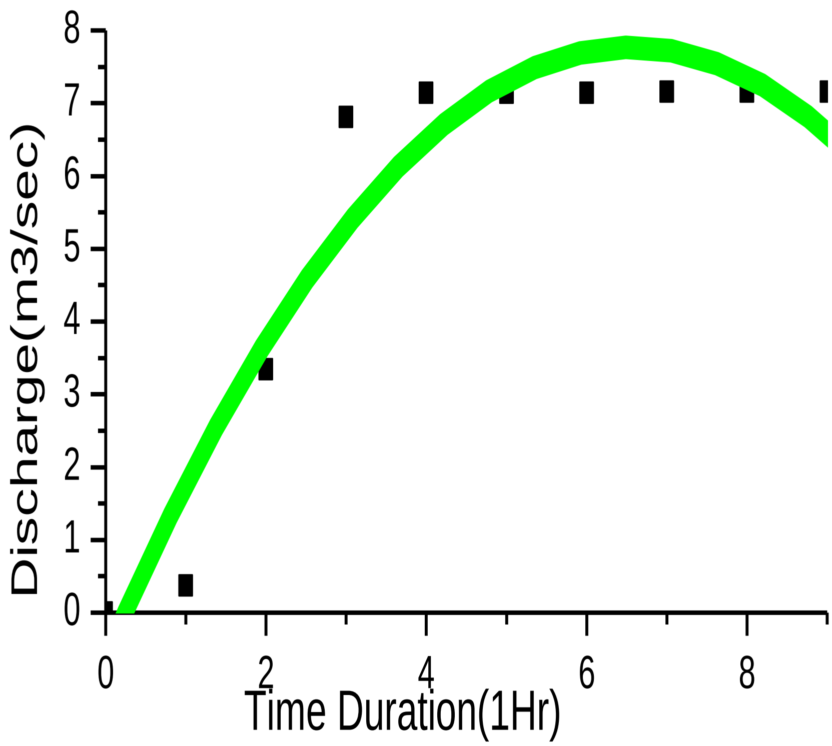

Fig. 4 Discharge vrs Time on 06-12-2023

Peak discharge =0.58m3/sec, values shows in figure 5, same two consecutive discharge readings on 10-12-2023.

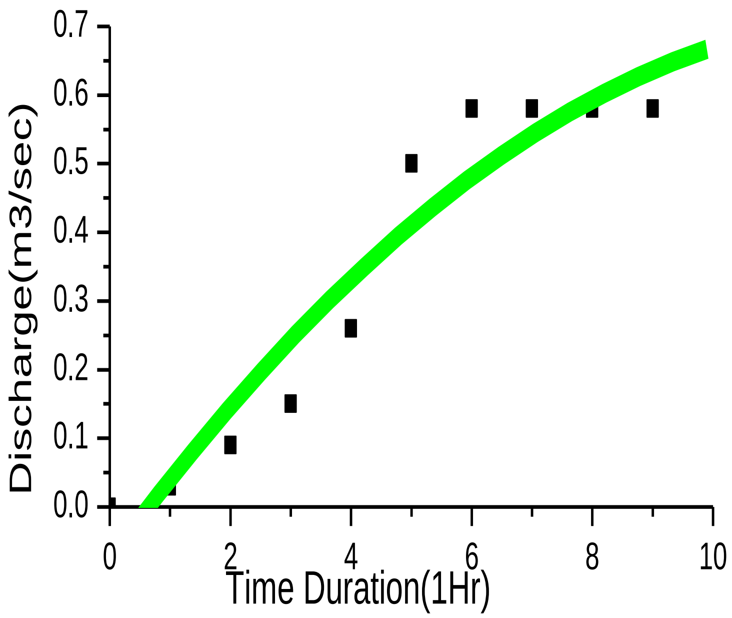

Fig. 5 Discharge vrs Time on 10-12-2023

Peak discharge =0.58m3/sec, values shows in figure 6, same two consecutive discharge readings on 18-12-2023.

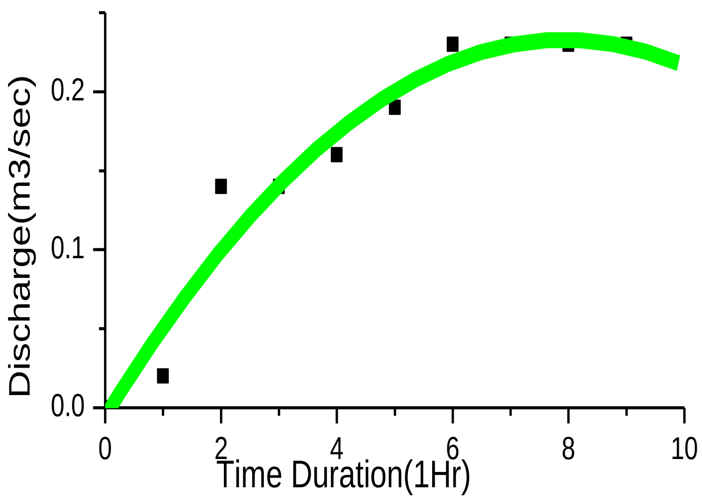

Fig. 6 Discharge vrs Time on 18-12-2023

Peak discharge =0.89m3/sec, values shows in figure 7, same two consecutive discharge readings on 27-01-2024.

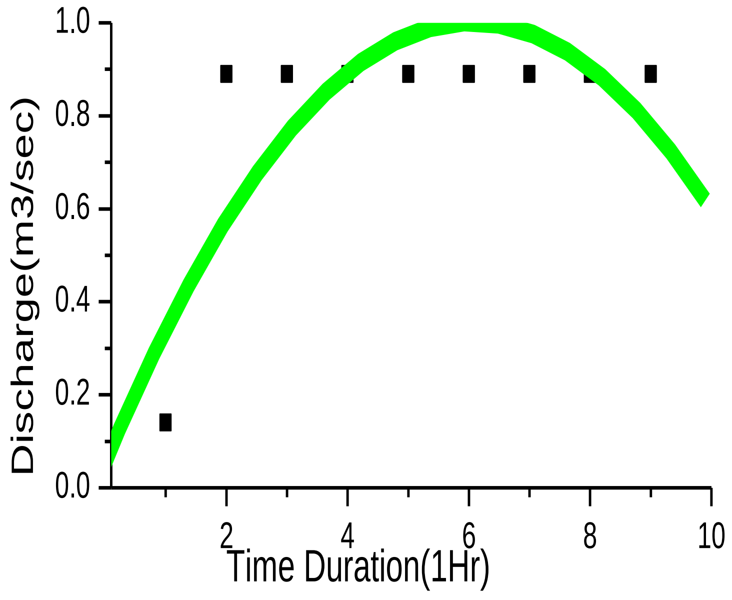

Fig. 7 Discharge vrs Time on 27-12-2024

V. Conclusions

The tipping bucket rain gauge is the most efficient, accurate, and affordable. GPRS-based tipping bucket rain gauge DL-2016 records data. A brick-sized block was erected above the fourth level and 0.6 metres from the parapet. Height: 1m; block size: 0.46*0.46m2. This block's 6" concrete bed was M-30 grade. After putting the rain gauge on the woodblock, we placed two 0.08*0.45m2 wooden blocks on the concrete bed with 0.01cm vertical spacing. Set up the rain gauge from levelling materials and slanted the two wooden blocks to let water from the bucket flow. Wooden block rain gauges with four corner screws must follow bucket flow below buckets. Use an extra connection to power a data logger after assembling the block and rain gauge. Not permitted to establish data logger in rain. Keep tight and dry near the power outlet. Hypertrm collects 1hr (mm/hr) precipitation from the GPRS-based datalogger DL-2016 and multiplies catchment area (km2) to compute discharge. The following table shows hydrograph precipitation. The unit hydrograph technique may predict peak-flood hydrographs using watershed infiltration parameters, rainfall, and unit hydrograph. The storm is built using the hydrograph of heavy rainfall surplus causing floods. Flood hydrographs are generated from catchment unit hydrographs by design storms. Draw mass day wise and month wise and analysis the data: From Dec, 2023 -there is some days only rain in that also one day 6th Dec is 7.16 m3 /sec and other are light rain, From Jan, 2024 - Recorded very light rain.

Future scope: Using flood frequency analysis, one may determine the greatest flood that is achievable for a certain return time. The implementation of models for the management of storm water. Simulations of rainfall and runoff in order to estimate flood peaks for smaller basins, the development of rainfall-runoff simulation models is being undertaken. The GPRS-based data logger DL-2016 was used to conduct an analysis of the yearly rainfall data.

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