[1]Agung Wahyudi Biantoro

[2]SI Wahyudi

[3]Moh. Faiqun Ni'am

[4]Subekti

Performance of Flood Early Detection System (FEDS) and Artificial Neural Network on Predicting Flood in the City

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Abstract: - An integrated flood detection system that is easily accessible to the public is one of the efforts to reduce the impact of flooding in flood-prone locations. The performance of flood detectors integrated with the internet helps make it easy Public for access information about possibility happening flood. Information about bulk rain, high water level, the water discharge will Becomes indication possibility happening downstream flooding. Tool prototype detector flood this be equipped with temperature and humidity sensor as addition information for society. Research results show that performance tool detector flood already good because capable give information related to data that can be made indication possibility happening flood. Sensors used have score small mistake and after calibrated got score constant for standardize results testing. Bulk sensor test results rain produces an average error of 3% and after calibration obtained constant of 1.03. High sensor test results water level has an average error of 1.07% and after calibrated obtained score constant of 0.98. Humidity sensor testing have the average error value is 3% and after calibration obtained score constant 1.03.

Keywords: FEDS, sensors, bulk rain, high water level, temperature, humidity, IoT

I.INTRODUCTION

High rainfall in season rain in the area urban be one reason frequent floods occurs in the downstream river like Jakarta. Jakarta is not only face threat flood consequence height bulk rain, but the flood that happened because existence overflow the river that happened consequence bulk rain high in the area plains tall such as Depok and Bogor. Disaster flood have very big impact, no only from aspect social but also from aspect economy because disaster flood could disable transportation and activities other.

Flood occur because water rises from different bodies of water or because bulk excessive rain , and that could happen on time certain along year. Flood is one frequent disasters occur consequence change severe climate. Reason main from flood is influenced no only by environment but also by activity influencing human climate [1]

Effort control flood need get attention because have nature very complex problem because involve many party. one effort that can conducted is with realize planning flood in the watershed area optimally carried out by various interested and supported parties based on regulation area, however permanent consider limited funds in development [2]. System warning early that gives information to Public about possibility happening Floods are very much needed by the community, so that Public could prepare self face possible flood come [3].

System Flood Early Warning (FEWS) is implemented in many areas part of the world, but warning early no always translated Becomes responsive emergency from all at risk individuals. Existence worries will lack of knowledge and practice policy subtraction risk disaster in between taker decision Becomes reason Public need information similar in order to prepare self [4].

Many stations warning flood has developed and installed in prosperous countries but cost making usually too high because of that development system detection early is one solution for above problem [5]. because of it's this model solve problem and support in minimal cost with power computing limited and reliability helpful height in detect the coming flood with help sensor network. This is where IoT comes into play role main because is the most efficient approach. This actually is system network electronic embedded, device software and sensors that send and receive data from distance far via the internet [6].

[1*,4]Engineering Department, Universitas Mercu Buana, Jakarta, Indonesia

[2,3]Engineering Department, Sultan Agung Islamic University, Semarang, Indonesia

II.MATERIALS AND METHODS

FEDS tool prototype modeller requires some data as reference the measurement. Based on technique data collection, research that will conducted use technique collection of primary data and secondary data. For more clear following description taking data:

1. Primary data

Primary data is data taken directly in the field. Primary data taken are:

a. Water level (m2)

b. Temperature and humidity

c. River discharge (m3/second)

d. flood discharge plan (m3/sec)

e. Sent time (seconds)

2. Secondary Data

Secondary data is the data taken from the data already exists, in study this is secondary data in question are:

a. Rainfall

b. Flood data

c. Meteorological hydro data

d. Topography

e. Watershed Area

Besides data collection for prepare modelling FEDS tools, some tools are also used as comparison or tool FEDS calibration that will made, namely:

a. Echo sounder tool (depth)

b. Environment meter (Temperature and Rh)

c. Rainfall Station/BMKG Data (CH)

d. Tachometer

e. Anemometer

f. ombrometer

g. CH sensor, ultrasonic sensor, temperature sensor, RH. Sensor

h. Thermometer, hygrometer

This study uses rainfall data as the main data to determine the feasibility of rainfall data using an Artificial Neural Network (ANN). An artificial neural network is a classification algorithm that imitates the working principle of a human neural network. This algorithm maps the input data at the input layer to the target at the output layer through the neurons in the hidden layer. Artificial neural network algorithms can be applied to solve various kinds of computational problems including for cases of classification, identification, prediction, anomaly detection and others.

III.RESULTS AND DISCUSSION

Making FEDS tool done with prepare secondary data that becomes reference in test the sensors that will used . FEDS tool will be equipped with four sensors namely bulk sensor rain sensor, humidity sensor, water discharge sensor and water level sensor . FEDS design can seen in Figure 1.

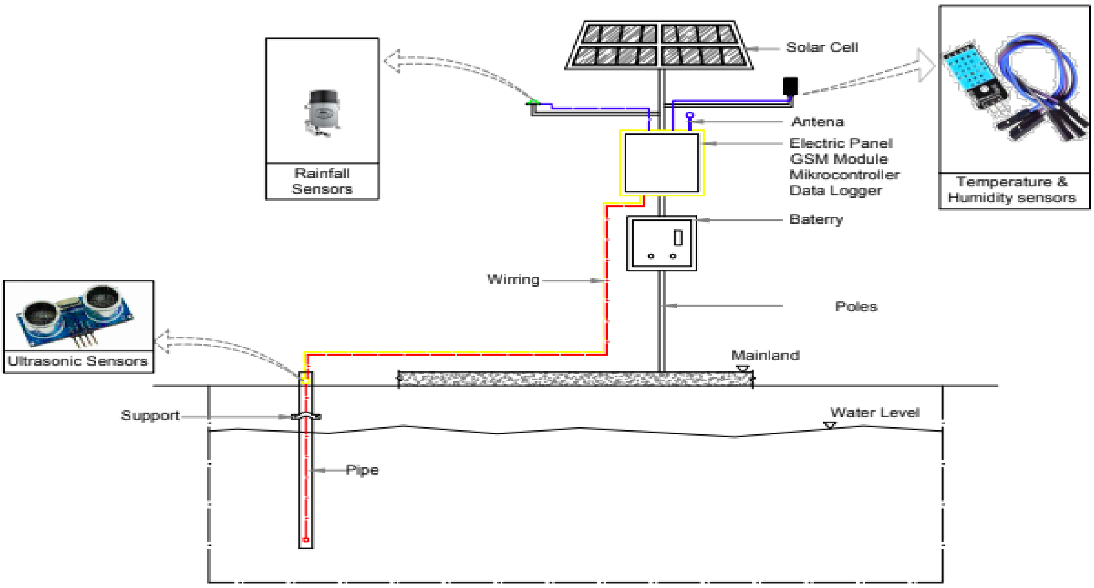

Figure. 1 FEDS Tool Design

Bulk data rain used is bulk data rainfall that occurred in the Bogor area and the data used is bulk data rain in the reservoir Katulampa , Bogor.

Table 1. Rainfall maximum Katulampa, Bogor

Year	Rainfall (X) mm
2010	61.75
2011	48.42
2012	42.92
2013	58.08
2014	58.58
2015	28.92
2016	50.33
2017	66.92
2018	55.92
2019	55.67
2020	68.83

Based on the data in Table 1 it can be is known that historically bulk rain maximum in the Katulampa region of 68.83 mm in 2020, while the lowest of 28.92 mm was found in 2015. The maximum water discharge data used also comes from from water discharge data in the Katulampa Region, Bogor.

Table 2. Maximum Water Discharge Katulampa , Bogor

Year	Water Discharge (m^3 / sec)
2010	44.54
2011	11.58
2012	13.02
2013	13.02
2014	16.96
2015	28.94
2016	32.13
2017	32.07
2018	34.93
2019	22.21
2020	00.00

Next high data water level used are data in Katulampa, Bogor.

Table 3. Katulampa Water Level, Bogor

Year	Water Level (m)
2010	-
2011	0.73
2012	0.75
2013	0.79
2014	0.90
2015	0.72
2016	0.75
2017	0.76
2018	0.78
2019	0.68
2020	0.71

Test FEDS tool done for test the accuracy of the sensors used in the tool for To do measurement. Bulk sensor testing rain compared with data released by BMKG at the same time with measurement.

Table 4. Rainfall Sensor Performance

Hari Ke	Curah Hujan (mm)	Curah Hujan BMKG (mm)	Error Value	Location
1	100	110	10%	**Jakarta 1**
2	110	110	0%	**Jakarta 1**
3	120	120	0%	**Jakarta 1**
4	90	100	11%	**Jakarta 1**
5	40	40	0%	**Jakarta 1**
6	45	45	0%	**Jakarta 1**
7	10	10	0%	**Jakarta 1**
8	5	5	0%	**Jakarta 1**
9	5	5	0%	**Jakarta 1**
10	5	5	0%	**Jakarta 1**
11	70	75	7%	**Jakarta 1**
12	90	90	3%	**Jakarta 1**
Total	**690**	**715**	**3%**	
	Average		**3%**	

Based on Table 4 looks existence difference Among BMKG data and designed system varied between 0 to with 10%, with average value deviation is 3%. Tool calibration is done by comparing the test equipment with the secondary data obtained. After doing the calculations, the constant obtained is k = 715 / 690 = 1.03. By getting a constant, you can measure the speed of the water flow by entering it to find out the value of the speed of the water flow, you can use the following equation (Prajitno, 1994).

$$v_{air} = k.\, v_{Alat\ uji\ (sebelum\ kalibrasi)}$$

$$v_{air} = 1{,}03\ ch_{Alat\ uji\ (sesudah\ kalibrasi)}$$

Next high sensor test water level can seen in the image below this.

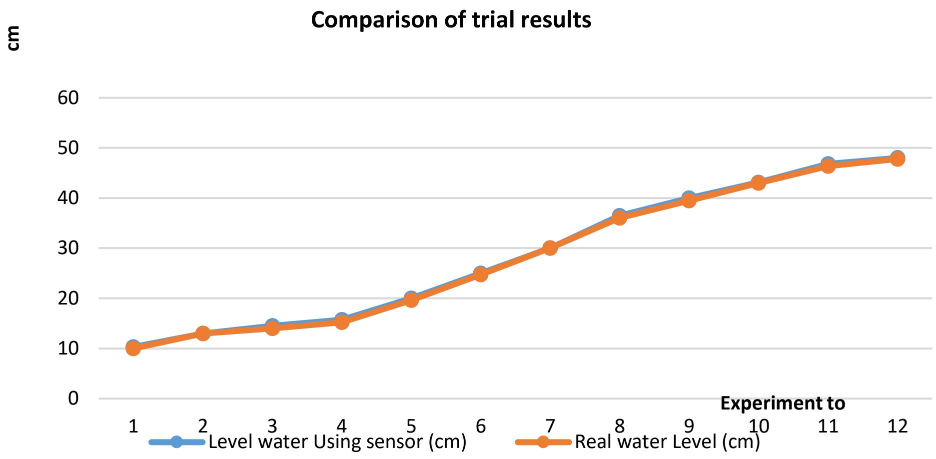

Figure. 2 Comparison of Water Level Sensor Results with Condition real

Difference measurement and system designed with meter brand X current varies is around 1.07%. Deviation value this counted enough small if compared with measurement manually. Calibration tool conducted with compare test equipment with standard tools. After doing the calculations, the constant obtained is 339.2/342.9 , namely k = 0.98 . By getting a constant, you can measure the speed of the water flow by entering it dan to find out the height value water level , you can use the following equation: (Prajitno, 1994).

$$h_{air} = k.\ h$$

$$h = 0{,}98.\ h_{Alat\ uji\ (sebelum\ kalibrasi)}$$

Humidity sensor test results show existence difference reach 10% with average deviation by 3%. To reduce this difference, it is necessary to calibrate the instrument. Tool calibration is done by comparing the test equipment with the secondary data obtained. Calculations to obtain constants using the equation, namely by making the coefficient value of k, which is derived from the comparison of standard values (BMKG data) with test equipment in mm units. The value of k obtained is k = 715 / 690 = 1.03. By getting a constant, you can do air humidity by entering dan to find out the value of air humidity, you can use the equation:

$$Rh_{udara} = k.\ Rh_{Alat\ uji\ (sebelum\ kalibrasi)}$$

$$Rh_{udara} = 1{,}03\ Rh_{Alat\ uji\ (sesudah\ kalibrasi)}$$

Testing is also carried out with use network nerves imitation. An artificial neural network is a classification algorithm that mimics the working principle of a human neural network. This algorithm maps the input data at the input layer to the target at the output layer through the neurons in the hidden layer. Artificial neural network algorithms can be applied to solve various kinds of computational problems including for cases of classification, identification, prediction, anomaly detection and others. Test results accuracy bulk rain use Matlab could see in Figure 4.11 below this.

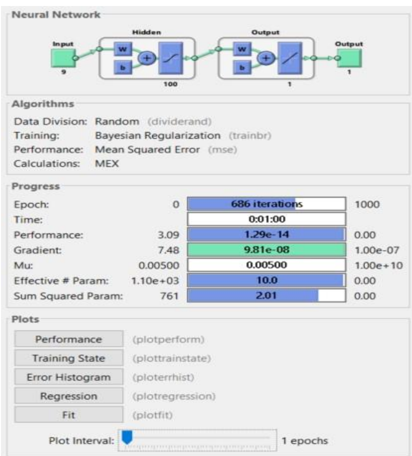

Figure. 3 Calculation results analysis Network nerves imitation use Matlab .

Based on Figure 3 can is known that performance training best found in the 686th *epochs* (repetition) with number 1.29 e-^{14} with a gradient of 9.81e-^{08} and a sufficient learning rate good. The linear function Y shows that function R shows number = 1 which means there is *relationship /* match between the target and the output. Analysis result data fit value for training, test and overall show score correlation R is 1. It means the value is fit and can next analysis (Figure 4).

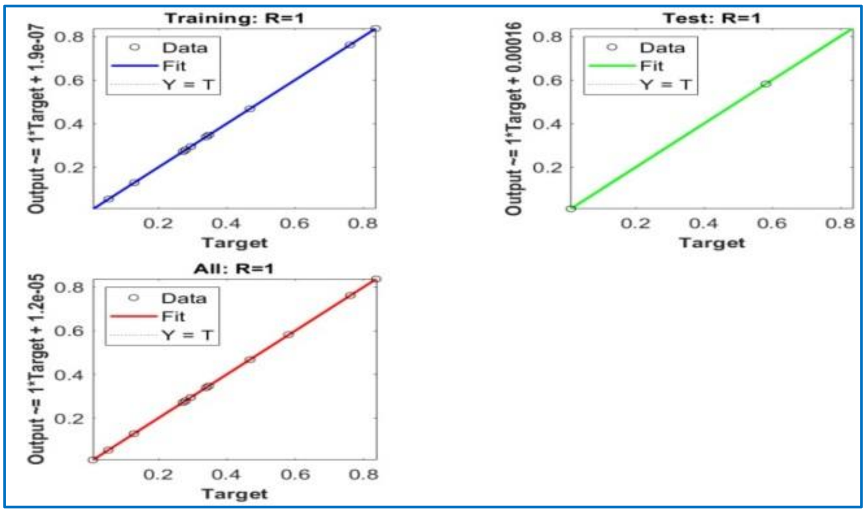

Figure 4 Calculation results Matlab: training and test with R

The linear function Y shows that function R shows number= 1 which means there is *relationship/*match between the target and the output.

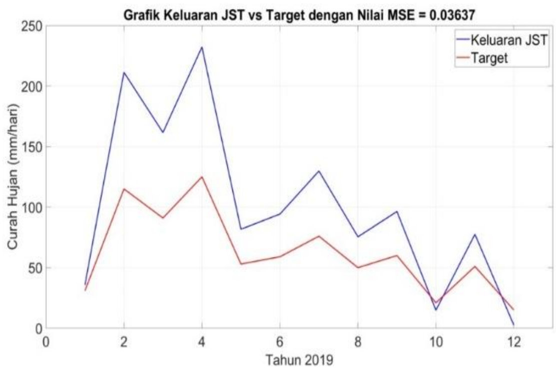

Figure 5 Trial calculation Matlab: bulk data prediction rain in 2019.

In Figure 5 above there is an MSE Value obtained of 0.03637. Coefficient value correlation and MSE value generated in the testing process show that network nerves imitation propagation come back enough good for predict bulk rain. Second score the could upgraded performance with method multiply training data as well as changing parameters that affect performance network such as error goals, number of epochs, architecture network, type function activation. Next moment tried in 2020 got results as following:

Figure 6 Trial calculation Matlab: bulk data prediction rain in 2020.

In Figure 6 , the MSE value obtained is 0.0 5 . The correlation coefficient and MSE values generated in the testing process indicate that the back propagation neural network is good enough to predict rainfall. Both of these values can be improved performance by multiplying the training data and changing parameters that affect network performance such as error goals, number of epochs, network architecture, type of activation function .

Influence bulk rain and water discharge in the upstream region (Katulampa - Bogor) to tell the water level in the downstream area (MT. Haryono-Jakarta) can analysed with use method multiple linear regression. Analysis result multiple linear regression could see in Table 5.

Table 5. Analysis Multiple Linear Regression

Variable	B	t value	Sig	Result
Kontanta	2,243	12 . 466	0.000	Significant
CH_Katulampa	0.015	4.764	0.000	Significant
DA_Katulampa	0.015	2,830	0.005	Significant
R2 -	0.297			
F Count		24,666	0.000	Significant

Table 5 shows that enhancement bulk rain and water discharge in the area upstream could influence level tall water level in the area downstream. In Table 5 it is shown that bulk rain and water discharge have score coefficient positive regression it means every increase in bulk rain and water discharge in the area Katulampa could increase level tall water level in the MT area. Haryono. Influence bulk rain and water discharge in Katulampa to tall water level at MT. Haryono showed with R value ^{2} of 0.297 or 29.7% which means every changes that occur in rainfall rain and water discharge in Katulampa could influence tall water level at MT. Haryono by 29.7%.

Based on results secondary data testing and processing could is known that FEDS tool made in prototype still have difference with standard , so that need made calculation for standardize data. Constant value for standardize tool the with analyse performance from supply generated power , high sensor water level, bulk sensor rain, temperature sensor and humidity sensor air .

The test results of the sensors show existence difference measurement among the result read by the sensor with condition original. The measurement results are also compared with tools that have been standardized for knowing big difference results measurement. Measurement result of course show that there is difference about 3% for each measurement. Because that, on some sensors made score constant for adapt results measurement.

Utilization of sensors in the prototype or system detection early flood has done by some study before. Technology and development system warning the flood that appears potential give solution alternative for allow counting right flood time and reliable. From traditional flood forecasting to the latest advancements with the integration of new technologies for a more reliable and accurate flood warning system [7]. Evaluate parts from system is very necessary because aim for knowing performance of each component and can knowing is condition of each component good or damaged so that could minimize error and damage performance system. After whole testing done , tool could work with good in accordance with design. However, still there is weakness in delivery WhatsApp [8]. Prototype system with take advantage of the proposed IoT has tested and working as proposed. He capable send message warning to user with when the water rises too with water speed rises to prediction how much fast flood happen. This has also been tested in controlled environment for evaluate performance [9]. Development system detection early flood by realtime required for give accurate information to Public [10]. Internet of Things (IoT)-based Arduino microcontroller technology has become a choice for To do approach supervision tall water level online . Ultrasonic sensor HC-SR 04 is used as reader water level and Arduino UNO R3 as processor as well as transmit data wirelessly to websites as well as via e-mail application ThingsSpeak [11]. Test tool detection early flood so that it runs normally and can give warning to inhabitant around . So that moment season rain no there is again affected house flood [12].

Impact height bulk rain could increase density mosquito. Enhancement optimum humidity and temperature increase density mosquito so that increase happening malaria [13]. Example area industry and housing show impact negative of the area inundation process, on the reliability operational real estate object. Reason manifestation and development of complex processes this revealed. For resolve impact anthropogenic in groundwater, has been proposed recommendation technology , which is economic and social [14].

IV.CONCLUSION

By whole performance FEDS tool is enough good in get data through existing sensors. Existence difference measurement between sensor and condition real nor with compare with tool standard could overcome through determination constant after to do calibration. Research results show that performance tool detector flood already good because capable give information related to data that can be made indication possibility happening flood. Sensors used have score small mistake and after calibrated got score constant for standardize results testing. Bulk sensor test results rain produces an average error of 3% and after calibration obtained constant of 1.03. High sensor test results water level has an average error of 1.07% and after calibrated obtained score constant of 0.98. Test humidity sensor have the average error value is 3% and after calibration obtained score constant 1.03.

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