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The Distribution Pattern and Rain Station Density on Kemuning Watershed - Madura Islandof Indonesia

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ABSTRACT

Background: Information the rain at a Watershed can be obtained by installing a graduated rain tools that form a network of rainfall in the watershed observation is concerned. The network is expected to provide data that describes the state of the rain in the basin. This is related to how much the distribution and density of rainfall stations in a watershed, can provide data that represent watershed is concerned, as well as how much the distribution and density affect the value of the average error rate data.
Objective: Problems amount and distribution of rain station in the watershed in Indonesia is still less attention. It proved to still lack basic instructions on the proper method of pattern for placement and deployment of a rain station. Determination of rain station network is not only limited to the determination of the number of station required in a watershed, but also where and patterns of spread. **Results:** The aim of this research is to get post network of hydrology effective and can deputize a catchment area so that earn minimization of is expense of required for the operation and conservancy. Data the used is monthly rainfall during 20 years start from 1992 till 2011. Method which is used in data analysis that is Kagan-Rodda method. Result of Kagan-Rodda method for the watershed Kemuning with amount of existing rain post in this time amount to 4 post with mistakes of calculation according to result of Analysis 5% of average error. Length of Kagan-Rodda was L = 9,692 km and the falttening error = 9,225, Interpolated error = 14,727. Amountly have answered the demand of but spreading of rain post not yet fulfilled what required by Kagan-Rodda method, so that require to be conducted by station reposition. Existing station will be reposition are station of Omben, Robatal, Sampang and Kedundung.

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INTRODUCTION

Development of water resources require hydrological data consisting of rainfall data, flow data and climate data. Hydrological basic data is very important as an input in calculating hydrological information ready for a development, research, and treatment of water resources (WMO,1981). Mistakes in the basic hydrological data monitoring in a watershed will generate data that are not ready to use right as the result of planning, research and management of water resources is not effective and efficient. Conversely, if the good hydrological data are monitored and supported by appropriate methods and quality of skilled human resources will be obtained by the planning, research and management of water resources effectively and efficiently (Chow,1988).

Information the rain at a Watershed (DAS) can be obtained by installing a graduated rain tools that form a network of rainfall in the watershed observation is concerned. The network is expected to provide data that describes the state of the rain in the basin (Dawdy,1972). This is related to how much the distribution and density of rainfall stations in a watershed, can provide data that represent watershed is concerned, as well as how much the distribution and density affect the value of the average error rate data. Problems station number and distribution of rainfall in the watershed in Indonesia is still less attention. This was proven yet their standard instructions on the proper method of pattern placement and deployment of a graduated station rain.

The quality of the basic data that will be used for an analysis of the river depends on how far the existing hydrological post, can monitor hydrological

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characteristics in a watershed (Solomon, 1972). How many hydrological posts need to be placed in a watershed to monitor hydrological characteristics accurately and correctly. The issue is whether the number of posts available current in a river basin is adequate, whether the number and location can monitor the hydrological characteristics of the area. Is not possible and we need a very expensive if the number of hydrological post very much. In a condition where the amount of the post too much then to analyze hydrological problems sometimes arise, which the post will be used whether in whole or in part only.

Determination of rainfall station network is not only limited to the determination of the number of stations required in a watershed, but also the place and the pattern of its spread. Instructions that are qualitative given by Rodda (1972), by utilizing the correlation coefficient rain. In the development of the distribution pattern of rainfall in each country will never be the same. Because the criteria on which to base used are not the same. Until now there has been encountered clear criteria and generally accepted to establish a regional observation network density. Moreover, its use in Indonesia require accuracy because there are many problems that can not be explained. This is primarily due to hydrological conditions in Indonesia is very much different from the situation in which the previous theory was developed.

MATERIALS AND METHODS

Research is done analyze the pattern of rain on the station and the density Kemuning watershed Madura Island of Indonesia. Analysis using the methods of Kagan-Rodda for the density of rainfall station was carried in Sampang District -Madura Island, East Java of Indonesia. Geographically Madura Island is located between 113°08'-113°39' East Longitudeand 06°05' - 07°13'North Latitude. Map location was as Figure 1.

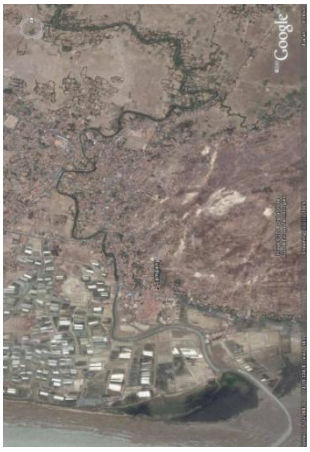

Fig. 1: Recording satellite Google, a situationat Kemuning downstream.

This analysis was carried out at Kemuning watershed in Sampang District-Madura Island. Kemuning river was consisted of some other rivers namely Omben river, Robatal river, Sampang river and Kedundung river. The data is needed in this research are analyzed the data of measurement result, regristration, research. The data used the data show :

1. Topography data scale 1 : 25.000
2. Map watershed from Balai River area East Java.
3. Precipitation data journeyman at the watershed 20 years from 1992 and with 2011

Kagan-Rodda Method:

The characteristic of Kagan-Rodda method was : 1) the prosedure and analysis was so simple; 2) the need of data which was supplied by available rainfall station could be sufficed; 3) it could give phenomena pattern of rainfall station distribution with the certain error.Essentially putting Kagan-Rodda method of statistical analysis and assoate network density measurements of rain with errors and errors interpolate flattening. With mark that variability quantity can room with a correlation between the station. A method af Kagan-Rodda station set a network of rain that meet the criteria set a mistake. Post the deployment of the criteria according to a method of rain Kagan-Rodda (Kagan 1972) depending on the distance between stations (L) obtained from the analysis. The formula used in this method was as follow :

$$r_{(d)} = r_{(o)} . e^{\left(\frac{-d}{d_o}\right)}$$

$$Z_1 = C_v . \sqrt{\frac{\left[1 - r_{(o)} + \left(\frac{0{,}23 \cdot \sqrt{A}}{d_{(o)} \cdot \sqrt{n}}\right)\right]}{n}}$$

$$Z_2 = C_v . \sqrt{\frac{1}{3}\left(1 - r_{(o)}\right) + \frac{0{,}32 r_{(o)} . \sqrt{\frac{A}{n}}}{d_o}}$$

$$L = 1{,}07 \sqrt{\frac{A}{n}}$$

Note :

$r_{(d)}$=coefficient of correlation for the distance of station (d)

$r_{(o)}$=coefficient of correlation for the shortest distance of stations

d=the distance inter station (km)

$d_{(o)}$=radius of correlation

Cv=coefficient of variation (km^2)

N=number of stations

Z_1=error of tool (%)

Z_2=interpolation error (%)

L=distance of inter station (km)

RESULTS AND DISCUSSIONS

By using the study of the theory can be determined on the correlation coefficient between the

post of rain and the distance between the post of rain. (Table 2 and table 3).

Table 1: Distribution of rainfall station exsiting.

No	Name of Station	Polygon Thiessen (km^2)
1	Omben	69,350
2	Robatal	138,634
3	Sampang	57,160
4	Kedundung	68,195

Table 2: Distance between station rain Kemuning Watershed (km).

	Omben	Robatal	Sampang	Kedundung
Omben	0	14,139	12,712	10,035
Robatal	14,139	0	20,544	12,453
Sampang	12,712	20,544	0	8,273
Kedundung	10,035	12,453	8,273	0
	12,295	15,712	13,843	10,254

Table 3: The average distance between the station and a correlation coefficient each station.

	The average distance of other stations	$r_{(hari)}$	$r_{(bulan)}$
Omben	12,295	0,949	0,995
Robatal	15,712	0,020	0,239
Sampang	13,843	0,886	0,763
Kedundung	10,254	0,583	0,747
	13,026	0,610	0,686

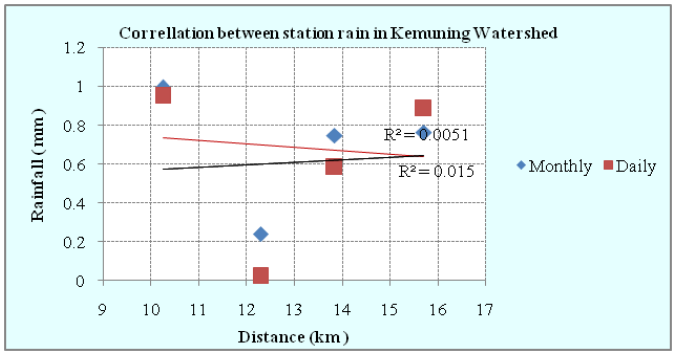

Fig.2: Chart corellation between the station in Kemuning watershed.

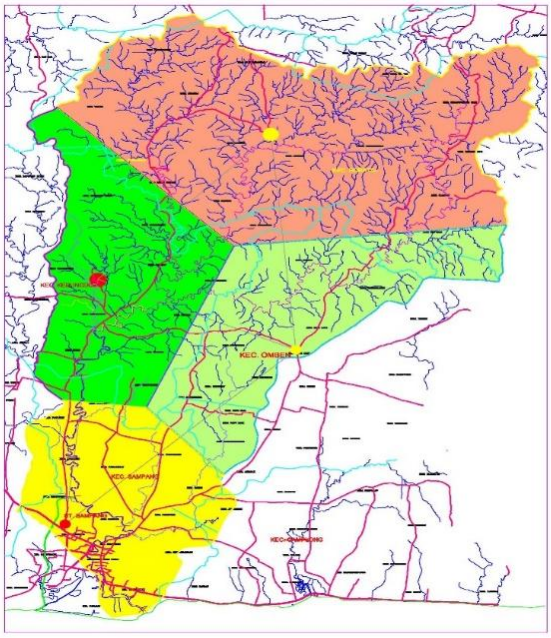

Fig. 3: Map of Kemuning Watershed.

Table 4: The number station, flattening error, Interpolated error and distance between post daily rainfall on kemuning watershed.

Area	328,2			N	: The number station			
$r_{(0)}$	0,0000			Z_1	: Flattening error			
ρ_0	0,000			Z_3	: Interplolated error			
Cv	0,000			L	: Distance between post			
N	**Z_1**	**Z_3**	**L**		**N**	**Z_1**	**Z_3**	**L**
1	20,962	18,795	19,384		51	2,298	10,895	2,714
2	13,810	16,534	13,707		52	2,274	10,878	2,688
3	10,890	15,426	11,192		53	2,252	10,861	2,663
4	9,226	14,727	9,692		54	2,230	10,845	2,638
5	8,124	14,229	8,669		55	2,208	10,830	2,614
6	7,329	13,851	7,914		56	2,187	10,814	2,590
7	6,722	13,550	7,327		57	2,167	10,800	2,568
8	6,240	13,302	6,853		58	2,148	10,785	2,545
9	5,845	13,093	6,461		59	2,128	10,771	2,524
10	5,515	12,913	6,130		60	2,110	10,757	2,503
11	5,233	12,757	5,845		61	2,092	10,744	2,482
12	4,989	12,619	5,596		62	2,074	10,731	2,462
13	4,775	12,496	5,376		63	2,057	10,718	2,442
14	4,586	12,385	5,181		64	2,040	10,705	2,423
15	4,417	12,285	5,005		65	2,023	10,693	2,404
16	4,265	12,194	4,846		66	2,007	10,681	2,386
17	4,127	12,110	4,701		67	1,991	10,669	2,368
18	4,001	12,033	4,569		68	1,976	10,657	2,351
19	3,886	11,961	4,447		69	1,961	10,646	2,334
20	3,780	11,895	4,334		70	1,946	10,635	2,317
21	3,682	11,833	4,230		71	1,932	10,624	2,301
22	3,591	11,775	4,133		72	1,918	10,614	2,284
23	3,506	11,721	4,042		73	1,904	10,603	2,269
24	3,427	11,670	3,957		74	1,891	10,593	2,253
25	3,353	11,621	3,877		75	1,877	10,583	2,238
26	3,284	11,576	3,802		76	1,865	10,573	2,224
27	3,218	11,532	3,731		77	1,852	10,564	2,209
28	3,156	11,491	3,663		78	1,839	10,554	2,195
29	3,098	11,452	3,600		79	1,827	10,545	2,181
30	3,042	11,415	3,539		80	1,815	10,536	2,167
31	2,990	11,379	3,482		81	1,804	10,527	2,154
32	2,940	11,346	3,427		82	1,792	10,518	2,141
33	2,892	11,313	3,374		83	1,781	10,509	2,128
34	2,846	11,282	3,324		84	1,770	10,501	2,115
35	2,803	11,252	3,277		85	1,759	10,492	2,103
36	2,761	11,223	3,231		86	1,748	10,484	2,090
37	2,722	11,196	3,187		87	1,738	10,476	2,078
38	2,683	11,169	3,145		88	1,728	10,468	2,066
39	2,647	11,144	3,104		89	1,717	10,460	2,055
40	2,612	11,119	3,065		90	1,707	10,453	2,043

Table 5: Design rainfall Kagan-Rodda Methods.

No	Tr	$R_{average}$	Standar Deviasi	Skewness	Probability	K	Design Rainfall	
	(year)	(Log)	(log)	(Cs)	(%)		Log	mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	1	1,539	0.264	-0,906	99	-2,116	0,981	9,570
2	2	1,539	0,264	-0,906	50	0,141	1,577	37,715
3	5	1,539	0,264	-0,906	20	0,854	1,764	58,137
4	10	1,539	0,264	-0,906	10	1,148	1,842	69,528
5	20	1,539	0,264	-0,906	5	1,362	1,898	79,150
6	25	1,539	0,264	-0,906	4	1,404	1,910	81,229
7	50	1,539	0,264	-0,906	2	1,546	1,947	88,494
8	100	1,539	0,264	-0,906	1	1,651	1,975	94,332
9	200	1,539	0,264	-0,906	0,5	1,744	1,999	99,821
10	1000	1,539	0,264	-0,906	0,1	1,893	2,039	109,308

Based on the graph the corellation across rain station Kemuning watershed (Fig 3), obtained :

$d_{(o)}$ = 13,026 km

$r_{(o)}$daily = 0,610

$r_{(o)}$monthly = 0,686

While to get the value of the coefficients variation rain obtained by average all data of rain and then calculated standard deviation and the average. Through the standard deviation and the results obtained the value of the variations of the coefficient 0,249 of rain. Of the result obtained, analysis can be done on a network of station rain in the Kemuning watershed. The analysis conducted include interpolate mistake, the average error and the distance between post and the number of post ideal available based on the level of his iniquity. The analysis of the results obtained can be seen in table 4.

Conclusion:

The analysis of rainfall station used Kagan-Rodda method was selected 4 rainfall station of 5 station available rainfall station which would produced accuracy rainfall analysis. The analysis was due to 5% of average error. Length of Kagan-Rodda was L = 9,692 km and the flattening error = 9,225, Interpolated error = 14,727

REFERENCES

Chow, V.T., D.R, L.W.Maidment, 1988.*Applied Hydrology*. Mac. Graw-Hill, New York.

Dawdy, D.R., M.E.Moss, N.C.dan Matalas, 1972., "Aplication of System Analysis to Network Design "*Cassbook on Hydrological Network Design Practice*, WMO-No 324, Geneva.

Rodda, J.C., 1972. "Planning The Apatial Distribution of Hydrometeorogical Stations to Meet an Error Criterion", *Cassbook on Hydrological Network Design Practise, WMO-No 324*, Geneva.

Rodda, J.C., A.Richard, Downing, M.Frank Law., 1976.*"System Hdrology"*. London-Boston : Newness-Butterworths.

Solomon, 1972., "Joint Maping" *Cassbook on Hydrological Network Design Practise*, WMO-No 324, Geneva.

World Meteorological Organization, 1981. *"Guide to Hydrological Practices"*, 4 th edition, WMO no 168, Genewa Switzerland.