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TREND ANALYSIS AND DATA MODELING OF DOMESTIC WASTEWATER QUALITY AS PREPARATION TOWARDS SMART ENVIRONMENT PLATFORM DEVELOPMENT

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ABSTRACT

In achieving the vision towards Smart City, related to the management of industrial sector, especially small and medium enterprises (MSMEs) or home-based businesses that contribute significantly to the economic sector, the management of household wastewater is one of the domains in the Smart Environment that must be a significant concern. River water pollution caused by domestic / home waste disposal and factories must be monitored on an ongoing basis. Sampling for laboratory tests is still used today. It is expected that in the future, wastewater quality testing in the laboratory can be replaced by the use of Internet of Things sensors so that wastewater quality can be monitored directly in real-time. However, the results of laboratory testing that have been collected can still be used to see trends in decreasing or improving water quality, so that they can be used as a reference for developing smart environment platforms shortly.

INTRODUCTION

The manufacturing industry sector contributed 20.07% to the economy, with a growth rate of 5.07% [1]. The increasing rate of economic growth also affects the quantity of wastewater discharged into rivers and lakes, which causes water pollution to become more serious. In this research, a Cimahi city case study was taken, because the data currently available are from the city of Cimahi. However, it does not reduce the possibility this research can be developed for a full area. According to the results of monitoring and testing of wastewater quality in the city of Cimahi, within one year with 2 wastewater quality testing periods in 2017 in 5 (five) existing rivers, almost all monitoring points are heavily polluted [2]. The status of river water quality can be evaluated using the STORET Method and Index Method of river water pollution based on the Decree of the Minister of Environment of the Republic of Indonesia No. 115 of 2003 concerning Guidelines for Determination of Water Quality Status.

The use of IoT to monitor water content has begun to be developed. However, the limitations of tools or sensors to detect water content are still limited both from components that are not yet available or from prices that are still expensive so that the laboratory test results are still being used in checking the river water content in Cimahi City. The parameters that affect river water conditions according to the Environmental Quality Index (IKLH) in 2017 are TSS, DO, BOD, COD, Total Phosphate, Fecal Coli, and Total Coliform [6].

Analysis of wastewater quality trends in Cimahi City is needed to be able to find out which content is increasing every year so that decisions can be taken early on how to overcome them by monitoring continuously and focused. The use of IoT can undoubtedly help in monitoring and evaluating quickly and real-time the condition of the water content in the Cimahi City river. But of course, due to the limitations of the tools mentioned earlier, data from laboratory tests are still needed. Therefore, this research is focused on pollution caused by domestic wastewater (originating from discharged from domestic activities such as bathing, eating, washing, home industries (UMKM), and so on [2]) and factory waste in river water in Cimahi city based on laboratory test results from 2012 to early 2020 sourced from the Cimahi City Environment Agency.

WATER POLLUTION FACTORS

Water pollution occurs when hazardous substances are mixed into clean water - often chemicals or microorganisms contaminate a river degrading water quality and rendering it dangerous toxic to humans, living animals, or the environment. Water is uniquely vulnerable to pollution. Water is able to dissolve more elements than any other liquid on earth. That is also the reason why water is so easily polluted. Toxic substances from agriculture, cities, household waste, and factories are ready to dissolve and mix with them, causing water pollution [12].

Based on data sourced from the Cimahi City Environment Agency, pollutant factors contained in these rivers, from seven parameters of wastewater quality, according to IKLH, are dominated by fecal coli and total coliform. Here are seven parameters that affect river water conditions, according to the 2017 Environmental Quality Index (IKLH) [6].

- Total Suspended Solids (TTS)
- Dissolved Oxygen (DO)
- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Total Phosphate (TP)
- Fecal Coli (FC)

• Total Coliform (TC)

Below is a table of laboratory test results sample in early 2020 calculated using the STORET method.

Table 1. Table of Water Pollution Index at Early 2019 [8]

Nama Sungai	Periode/ Tanggal	TSS	DO	BOD	COD	Fosfat	Fecal Coli	Total-Coliform	(Ci/Lij)R	(Ci/Lij) M	(Ci/Lij)R2	(Ci/Lij)M2	Pij	Status Mutu
Cimahi Hulu	05 April 2019	81.00	7.19	4.00	12.00	0.28	1,100,000	1,100,000	189.5359742	1100	35923.88552	1210000	789.2793819	berat
Cimahi Tengah	01 April 2019	62.00	6.04	4.00	11.00	0.36	240,000	1,100,000	66.31272364	240	4397.377317	57600	176.0644446	berat
Cimahi Hilir	05 April 2019	20.00	6.19	6.00	27.00	0.33	1,100,000	1,100,000	189.2000098	1100	35796.64371	1210000	789.2390778	berat
Cisangkan Hulu	01 April 2019	23.00	4.25	2.00	7.00	0.78	460,000	460,000	79.11404138	460	6259.031544	211600	330.0447178	berat
Cisangkan Tengah	01 April 2019	25.00	1.00	6.00	23.00	0.86	1,100,000	1,100,000	189.6598484	1100	35970.85811	1210000	789.2942601	berat
Cisangkan Hilir	02 April 2019	20.00	1.73	19.00	42.00	0.94	93,000	240,000	21.75488211	93	473.2748956	8649	67.53619361	berat
Cibabat Hulu	04 April 2019	26.00	5.38	6.00	29.00	0.48	1,100,000	1,100,000	189.4203509	1100	35880.06935	1210000	789.2655033	berat
Cibabat Tengah	04 April 2019	21.00	2.10	24.00	60.00	0.93	1,100,000	1,100,000	190.3701551	1100	36240.79597	1210000	789.3797552	berat
Cibabat Hilir	05 April 2019	32.00	2.27	46.00	122.00	1.08	1,100,000	1,100,000	191.0279069	1100	36491.66123	1210000	789.4592014	berat
Cibaligo Hulu	04 April 2019	82.00	4.87	19.00	39.00	0.51	1,100,000	1,100,000	190.2536434	1100	36196.44884	1210000	789.3657102	berat
Cibaligo Tengah	04 April 2019	20.00	2.67	57.00	104.00	0.39	1,100,000	1,100,000	190.4014811	1100	36252.72402	1210000	789.3835329	berat
Cibaligo Hilir	02 April 2019	35.00	1.00	129.00	228.00	3.65	1,100,000	1,100,000	193.420401	1100	37411.4515	1210000	789.7504199	berat
Cibeureum Hulu	01 April 2019	15.00	5.74	7.00	26.00	0.48	460,000	460,000	79.54509384	460	6327.421954	211600	330.0965177	berat
Cibeureum Tengah	02 April 2019	72.00	3.31	50.00	84.00	0.44	240,000	240,000	44.65681079	240	1994.23075	57600	172.6184097	berat
Cibeureum Hilir	02 April 2019	38.00	3.30	24.00	50.00	0.82	460,000	460,000	80.69042874	460	6510.945291	211600	330.2354806	berat

INGREDIENTS AND METHODS

Location of Sampling

The locations used as sampling sites are in 5 rivers in Cimahi City (Table 2). The data collected was laboratory test results from 2012 to early 2020 with two periods each year, i.e., at the beginning and end of the year, as well as at 3 locations for each river.

Table 2. Table Location for Taking Wastewater Samples

River Name	Coordinate
Cimahi Headwaters	E 107'33.618' S 06'51.309'
Cimahi Middle	E 108'32.466' S 06'53.606'
Cimahi Downstream	E 107° 32' 304" S 06° 55' 203"
Cisangkan Headwaters	E 107'32.181' S 06'52.223'
Cisangkan Middle	E 108'31.818' S 06'52.867'
Cisangkan Downstream	E 107° 32' 006" S 6° 55' 092"
Cibabat Headwaters	E 107'33.694' S 06'53.373'
Cibabat Middle	E 107'32.892' S 06'54.016'
Cibabat Downstream	E 107° 33' 008" S 06° 55' 502"
Cibaligo Headwaters	E 107'33.329' S 06'53.876'
Cibaligo Middle	E 107´33.108' S 06'54.523'
Cibaligo Downstream	E 107° 32' 630" S 06° 55' 270"
Cibeureum Headwaters	E 107° 34' 130" S 06° 54' 622"
Cibeureum Middle	E 107'33.923' S 06'55.164'
Cibeureum Downstream	E 107'34.130' S 06'54.622'

Data Collection Methods and Techniques

The measurement of river water content is carried out by a laboratory designated by the Cimahi City Environment Agency, which is recorded and reported periodically. Data from the results of this laboratory report are stored in the Department of the Environment so that it is used directly in this study. Another method we use to collect data is to install a prototype of an IoT sensor at some polluted sewer points. The data analysis methodology used in this research is a statistical method of analyzing the Mann-Kendall Test (MKT).

There are several studies on environmental pollution using MKT trend analysis as a statistical tool to predict and analyze the decrease and increase in statistical trends of pollutants that are different from periodic sampling. Among them are statistical trend analysis research and modeling of air pollutant estimates [7] and research on the use of Mann-Kendall on pollutant trends, temperature, and humidity in Indian urban stations with verification of estimates using various ARIMA models performed by Sutapa Chaudhuri and D Dutta [8].

MKT is a non-parametric trend analysis technique to identify patterns of increase and decrease in time series data patterns that compare the relative magnitude of the sample data rather than the value of the data itself (Gilbert 1987) [9] with the following formula:

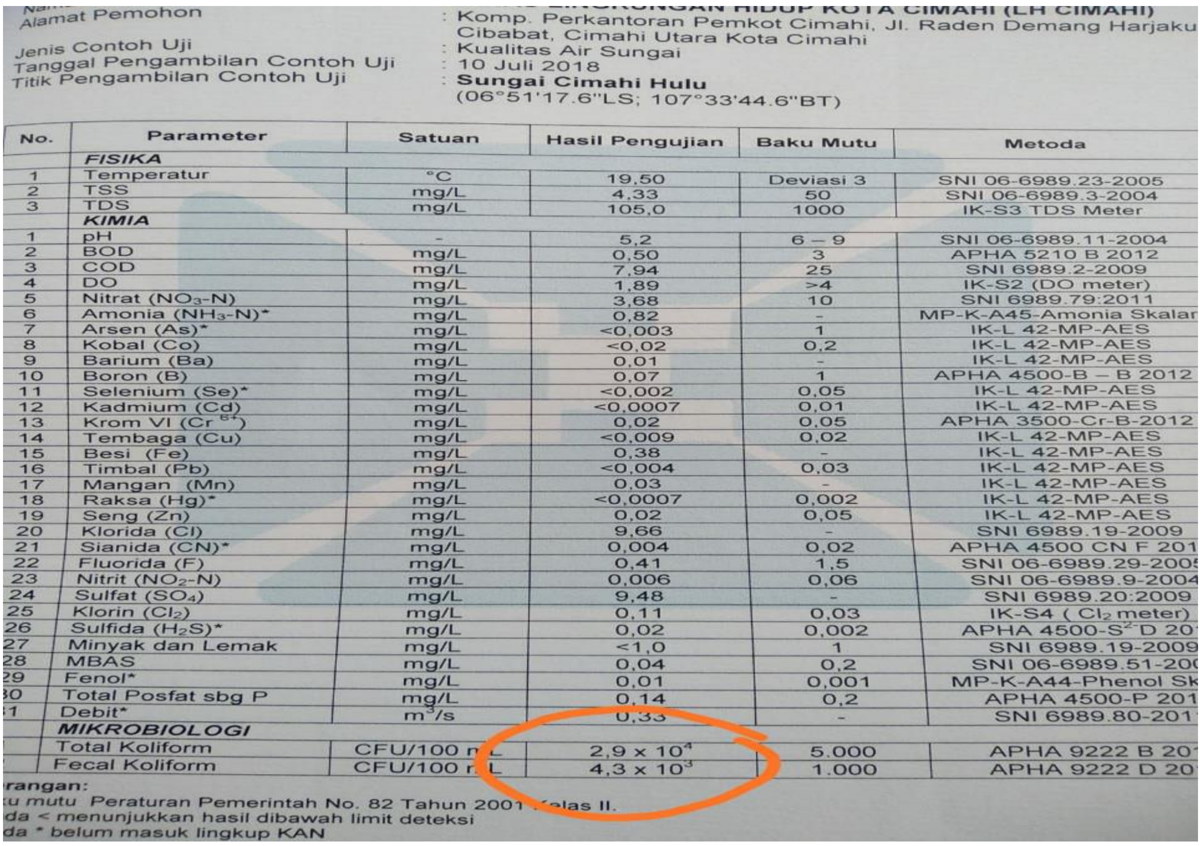
$$S = \sum_{k=1}^{n=1} \sum_{j=k+1}^{n} Sgn(x_j - x_k)$$

$$Sgn(x_j - x_k) = \begin{cases} -1 & if\ (x_j - x_k) < 0 \\ 0 & if\ (x_j - x_k) = 0 \\ +1 & if\ (x_j - x_k) > 0 \end{cases} \qquad (2)$$

The above formula is usually used for data totaling 40 or less, where x is the sample value, and i on x_i is the data in the year i. Because the data used are sample data from 2012 to early 2020 with two retrieval periods each year, the total amount of data for each water content parameter is 13 values.

The reason for using this MKT is not only because of the small amount of data and period but also because the MKT procedure allows missing values, and the data does not need to be in accordance with a particular distribution. In addition, MKT allows data reported as traces less than the usual detection limit by setting general values that are smaller than the smallest values measured in the data set. Of course, if the detection limit is acceptable in the context of the population being sampled.

Figure 1. Capture wastewater data using the IoT sensor (personal documentation)



HIDUP KOTA CIMAHI (LH CIMAHI)

Alamat Pemohon : Komp. Perkantoran Pemkot Cimahi, Jl. Raden Demang Harjaku Cibabat, Cimahi Utara Kota Cimahi

Jenis Contoh Uji : Kualitas Air Sungai

Tanggal Pengambilan Contoh Uji : 10 Juli 2018

Titik Pengambilan Contoh Uji : **Sungai Cimahi Hulu** (06°51'17.6"LS; 107°33'44.6"BT)

No.	Parameter	Satuan	Hasil Pengujian	Baku Mutu	Metoda
	FISIKA				
1	Temperatur	°C	19,50	Deviasi 3	SNI 06-6989.23-2005
2	TSS	mg/L	4,33	50	SNI 06-6989.3-2004
3	TDS	mg/L	105,0	1000	IK-S3 TDS Meter
	KIMIA				
1	pH	-	5,2	6 – 9	SNI 06-6989.11-2004
2	BOD	mg/L	0,50	3	APHA 5210 B 2012
3	COD	mg/L	7,94	25	SNI 6989.2-2009
4	DO	mg/L	1,89	>4	IK-S2 (DO meter)
5	Nitrat (NO_3-N)	mg/L	3,68	10	SNI 6989.79:2011
6	Amonia (NH_3-N)*	mg/L	0,82	-	MP-K-A45-Amonia Skalar
7	Arsen (As)*	mg/L	<0,003	1	IK-L 42-MP-AES
8	Kobal (Co)	mg/L	<0,02	0,2	IK-L 42-MP-AES
9	Barium (Ba)	mg/L	0,01	-	IK-L 42-MP-AES
10	Boron (B)	mg/L	0,07	1	APHA 4500-B – B 2012
11	Selenium (Se)*	mg/L	<0,002	0,05	IK-L 42-MP-AES
12	Kadmium (Cd)	mg/L	<0,0007	0,01	IK-L 42-MP-AES
13	Krom VI (Cr^{6+})	mg/L	0,02	0,05	APHA 3500-Cr-B-2012
14	Tembaga (Cu)	mg/L	<0,009	0,02	IK-L 42-MP-AES
15	Besi (Fe)	mg/L	0,38	-	IK-L 42-MP-AES
16	Timbal (Pb)	mg/L	<0,004	0,03	IK-L 42-MP-AES
17	Mangan (Mn)	mg/L	0,03	-	IK-L 42-MP-AES
18	Raksa (Hg)*	mg/L	<0,0007	0,002	IK-L 42-MP-AES
19	Seng (Zn)	mg/L	0,02	0,05	IK-L 42-MP-AES
20	Klorida (Cl)	mg/L	9,66	-	SNI 6989.19-2009
21	Sianida (CN)*	mg/L	0,004	0,02	APHA 4500 CN F 201
22	Fluorida (F)	mg/L	0,41	1,5	SNI 06-6989.29-2005
23	Nitrit (NO_2-N)	mg/L	0,006	0,06	SNI 06-6989.9-2004
24	Sulfat (SO_4)	mg/L	9,48	-	SNI 6989.20:2009
25	Klorin (Cl_2)	mg/L	0,11	0,03	IK-S4 (Cl_2 meter)
26	Sulfida (H_2S)*	mg/L	0,02	0,002	APHA 4500-S^{2-}D 20
27	Minyak dan Lemak	mg/L	<1,0	1	SNI 6989.19-2009
28	MBAS	mg/L	0,04	0,2	SNI 06-6989.51-200
29	Fenol*	mg/L	0,01	0,001	MP-K-A44-Phenol Sk
30	Total Posfat sbg P	mg/L	0,14	0,2	APHA 4500-P 201
31	Debit*	m^3/s	0,33	-	SNI 6989.80-201
	MIKROBIOLOGI				
	Total Koliform	CFU/100 mL	$2,9 \times 10^4$	5.000	APHA 9222 B 20
	Fecal Koliform	CFU/100 mL	$4,3 \times 10^3$	1.000	APHA 9222 D 20

rangan:
u mutu Peraturan Pemerintah No. 82 Tahun 2001 Kelas II.
da < menunjukkan hasil dibawah limit deteksi
da * belum masuk lingkup KAN

Figure 2. example of raw data from laboratory result test

WATER CONTENT TREND ANALYSIS

In this study, there was a merging of data from the laboratory with data from the IoT sensor. Then the data analysis and modeling are carried out to prepare machine learning modeling, which will be carried out in further research.

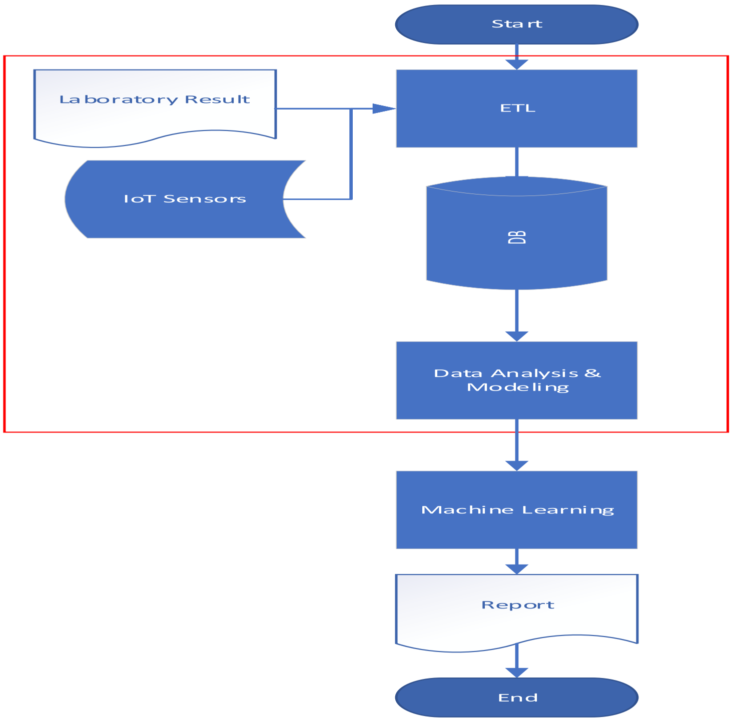


Figure 1. Research map

This wastewater trend analysis aims to study changes in wastewater quality based on the time from year to year in Cimahi City rivers. In conducting MKT calculations, in this study, GSI Mann-Kendall Toolkit from GSI Environmental Inc. was used. To simplify and speed up calculations [10]. The GSI Mann-Kendall Toolkit can help analyze wastewater datasets collected from data sources so that this method can determine quantitatively whether the measured chemical, physical, and biological concentrations increase, decrease, or be stable over time, based on the use of the Mann statistical method - Kendall. Modeling using this software can be applied to data from monitoring points where wastewater sampling and testing have been conducted several times before to evaluate the concentration trends of each chemical, physical, and biological at each sampling location [11].

Calculation of the Mann-Kendall Test using the GSI Mann-Kendall Toolkit

Data collected from 2012 to early 2020 with each year having two sampling periods will be sorted by river name, location, and type of water content parameters to be analyzed for trends. One example of the results of data sorting can be seen in (Figure 2).

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 12-Dec-19 | Job ID: Sungai Cibabat
Facility Name: DLH Kota Cimahi | Constituent: Chemical Oxygen Demand (COD)
Conducted By: | Concentration Units: mg/L

Sampling Point ID:		Hulu	Tengah	Hilir
Sampling Event	Sampling Date	CHEMICAL OXYGEN DEMAND (COD) CONCENTRATION (mg/L)		
1	8-May-12	56.2	184	272
2	12-Nov-13	94.3	602	283
3	7-May-14	116	234	280
4	12-Oct-15	202	410	763
5	7-May-14	116	234	280
6	12-Oct-15	202	410	763
7	10-Mar-16	68.9	105	211
8	10-Nov-16	66	362	385
9	12-Sep-17	45	104	269
10	27-Nov-17	24.99	98.71	1.6456
11	10-Jul-18	92.95	105.89	99.52
12	21-Nov-18	49.19	128.62	76.86
13	4-Apr-19	29	60	122.00
14				
15				
16				
17				
18				
19				
20				
Coefficient of Variation:		0.65	0.71	0.80
Mann-Kendall Statistic (S):		-32	-38	-34
Confidence Factor:		97.1%	98.9%	97.9%
Concentration Trend:		Decreasing	Decreasing	Decreasing

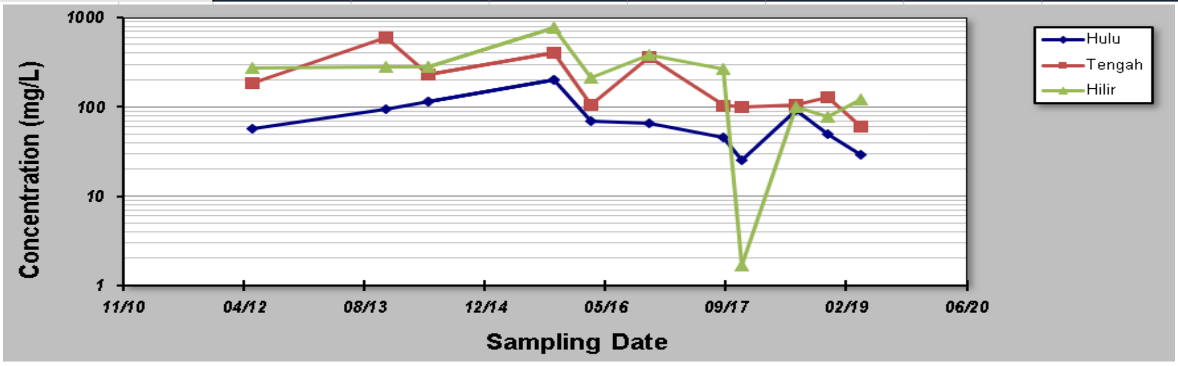


Figure 2. The figure of calculation of COD content parameters in water in the Cibabat river

In ETL, data cleaning is done, namely by eliminating errors and missing values from the sensor. Formatting is done by standardizing the data according to the needs of analysis and machine learning, then loading it into the database:

Figure 3. ETL process

The following (Table 3) is an example of raw data from the IoT sensor and laboratory results that have been combined. The total data collected is 300,000 records. After cleaning and formatting, the data is reduced to 283,740 records.

Table 3. Table of measurement table for wastewater using the IoT sensor

river	date	time	quality_value
1	2020-01-01	00:00:00	1=9.1#6=85#7=18#8=1092#10=76#11=25#12=1115#13=1
2	2020-01-01	00:00:00	1=10.3#6=86#7=25#8=1278#10=85#11=28#12=1304#13=0
3	2020-01-01	00:00:00	1=10#6=87#7=25#8=1293#10=110#11=28#12=1489#13=1
4	2020-01-01	00:00:00	1=5.7#6=83#7=20#8=128#10=61#11=26#12=198#13=0
5	2020-01-01	00:00:00	1=8.1#6=85#7=26#8=357#10=67#11=28#12=395#13=0
6	2020-01-01	00:00:00	1=11.2#6=86#7=31#8=589#10=76#11=30#12=603#13=0
7	2020-01-01	00:00:00	1=9.2#6=85#7=18#8=988#10=57#11=24#12=804#13=1
8	2020-01-01	00:00:00	1=13#6=85#7=27#8=1149#10=66#11=26#12=998#13=0
9	2020-01-01	00:00:00	1=12#6=88#7=32#8=1267#10=81#11=29#12=1213#13=0
10	2020-01-01	00:00:00	1=7#6=85#7=18#8=812#10=81#11=24#12=996#13=1
11	2020-01-01	00:00:00	1=9.5#6=86#7=18#8=1039#10=110#11=23#12=1168#13=1
12	2020-01-01	00:00:00	1=12#6=88#7=28#8=1281#10=122#11=25#12=1282#13=0
13	2020-01-01	00:00:00	1=5.6#6=84#7=18#8=96#10=67#11=28#12=105#13=0
14	2020-01-01	00:00:00	1=6.9#6=85#7=18#8=332#10=84#11=28#12=236#13=1
15	2020-01-01	00:00:00	1=4.5#6=87#7=18#8=295#10=78#11=28#12=330#13=0

RESULTS FROM TREND ANALYSIS

The results of the calculation of wastewater quality trend analysis in Cimahi City on the COD indicator as in Table 4.

Table 4. Table of Chemical Oxygen Demand (COD) Measurement Results using the GSI Mann-Kendall Toolkit

Nama Sungai	Cibabat			Cibeureum		
Tgl Sampel	Hulu	Tengah	Hilir	Hulu	Tengah	Hilir
8-May-12	56.2	184	272	51.3	71.7	2867
12-Nov-13	94.3	602	283	114	128	131
7-May-14	116	234	280	112	118	91.9
12-Oct-15	202	410	763	118	126	270
7-May-14	116	234	280	112	118	91.9
12-Oct-15	202	410	763	118	126	270
10-Mar-16	68.9	105	211	64	64.7	39.6
10-Nov-16	66	362	385	64	45	61
12-Sep-17	45	104	269	72	156	77
27-Nov-17	24.99	98.71	1.6456	75.23	61.97	68.38
10-Jul-18	92.95	105.89	99.52	76.16	77.7	98.26
21-Nov-18	49.19	128.62	76.86	37.75	94.55	80.91
4-Apr-19	29	60	122.00	26	84	50
Koefisien variasi	0.65	0.71	0.80	0.40	0.34	2.38
Statistik Mann-Kendall (S)	-32	-38	-34	-27	-14	-34
Faktor Konfidensi	97.1%	98.9%	97.9%	94.3%	78.2%	97.9%
Tren Konsentrasi	Decreasing	Decreasing	Decreasing	Prob. Decreasing	Stable	Decreasing

Cisangkan			Cibaligo			Cimahi		
Hulu	Tengah	Hilir	Hulu	Tengah	Hilir	Hulu	Tengah	Hilir
46.5	54.8	83.4	24.4	308	380	14.4	14.5	34.7
112	147	552	73	493	373	0	38	267
80.4	196	190	340	395	290	29.9	34.8	33.1
187	246	315	176	778	627	18.4	35.6	762
80.4	196	190	340	395	290	29.9	34.8	33.1
187	246	315	176	778	627	18.4	35.6	762
60.9	71.3	83.9	52.7	162	117	80.1	49.7	111
50.3	74	96	31	196	270	31	26	30
28	109	668	39	253	387	17	25	139
26.32	34.15	56.51	69.07	233.42	280.01	85.65	39.28	52.08
36.28	78.77	92.96	113.42	145.13	130.62	7.94	57.15	97.04
61.49	76.93	18.25	57.61	80.47	180.61	19.81	49.72	32.59
7	23	42	39	104	228	12	11	27
0.77	0.65	0.98	0.94	0.70	0.50	0.92	0.38	1.45
-36	-24	-30	-15	-44	-32	6	12	-24
98.5%	91.8%	96.2%	79.9%	99.7%	97.1%	61.7%	74.5%	91.8%
Decreasing	Prob. Decreasing	Decreasing	Stable	Decreasing	Decreasing	No Trend	No Trend	Prob. Decreasing

There are many trends in decreasing levels of COD in river water that can cause pollution levels to increase. Because of the higher the COD value, the better the water quality. The lower the COD content, the more susceptible to pollution. Therefore it must be sought the cause of the reduction in COD levels in river water immediately so that prevention can be done to reduce COD levels next year. Besides, because of seeing the declining trend of COD, IoT for COD is needed immediately to be able to monitor the COD content in real-time from the Office of the Environment Office without having to wait for the sampling period.

Table 5. Table of measurement table for wastewater using the IoT sensor after formating to training data

training_value	pollution_level	class
pH=4#suhuAir=27#suhuUdara=27#TDS=983#Turbidity=108...	4	1
pH=5#suhuAir=26#suhuUdara=27#TDS=1186#Turbidity=11...	3	0
pH=5#suhuAir=25#suhuUdara=27#TDS=1033#Turbidity=10...	3	0
pH=5#suhuAir=26#suhuUdara=27#TDS=1028#Turbidity=11...	3	0
pH=4#suhuAir=26#suhuUdara=26#TDS=912#Turbidity=111...	4	1
pH=5#suhuAir=25#suhuUdara=27#TDS=1098#Turbidity=10...	3	0
pH=5#suhuAir=25#suhuUdara=28#TDS=1090#Turbidity=11...	3	0
pH=5#suhuAir=18#suhuUdara=24#TDS=951#Turbidity=105...	3	0

STORET analysis for river wastewater quality data in cimahi city

Table 6. Storet analysis for wastewater quality

river	min_val	max_val	ave_val	storet	storet_class
1	-2#0#0#0#	-2#0#-1#-1#	0#0#0#0#	-6	B
2	-2#0#0#0#	-2#-1#-1#-1#	0#0#0#0#	-7	B
3	-2#0#0#0#	-2#-1#-1#-1#	0#0#0#-3#	-10	B
4	-2#0#0#0#	-2#0#-1#-1#	0#0#0#0#	-6	B
5	-2#0#0#0#	-2#-1#-1#-1#	0#0#0#-3#	-10	B
6	-2#0#0#0#	-2#-1#-1#-1#	-6#-3#0#-3#	-19	C
7	-2#0#0#0#	-2#0#-1#-1#	0#0#0#0#	-6	B
8	-2#0#0#0#	-2#-1#-1#-1#	0#0#0#0#	-7	B
9	-2#0#0#0#	-2#-1#-1#-1#	0#0#0#-3#	-10	B
10	-2#0#0#0#	-2#0#-1#-1#	0#0#0#0#	-6	B
11	-2#0#0#0#	-2#-1#-1#-1#	0#0#0#0#	-7	B
12	-2#0#0#0#	-2#-1#-1#-1#	0#-3#0#0#	-10	B
13	-2#0#0#0#	-2#0#-1#-1#	0#0#0#0#	-6	B
14	-2#0#0#0#	-2#-1#-1#-1#	0#0#0#0#	-7	B
15	-2#0#0#0#	-2#-1#-1#-1#	0#0#0#0#	-7	B

CONCLUSION

The results of this study are which parameter indicators are experiencing a downward trend and which are experiencing an upward trend. Each parameter has a different percentage of pollution indicators. COD should have an increasing trend so that pollution can be prevented, but for fecal coli and total coliform must have a downward trend to prevent river water pollution.

Besides, chemical and physical factors also play a significant role in causing pollution in rivers.

Analysis of wastewater quality trends is also expected to be one of the information that can be used as supporting material in the use of IoT which is needed based on the trend of water content from laboratory test results from year to year so that the development of Smart Environment in Cimahi City becomes more on target.

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