CISADANE RIVER WATER POLLUTION

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ABSTRAK

PENCEMARAN AIR DI SUNGAI CISADANE

Sungai Cisadane berfungsi sebagai sumber air baku untuk sistem penyediaan air bersih wilayah Serpong dan Tangerang, Kabupaten Tangerang. Meskipun demikian, sungai Cisadane berfungsi pula sebagai tempat pembuangan limbah bagi rumah tangga dan industri yang berlokasi di sepanjang sungai tersebut.

Untuk memperoleh gambaran mengenai tingkat pencemaran airnya, pada bulan September 1992 telah dilakukan pengambilan sampel air sungai Cisadane. Sampel air diambil di sebelah hulu intake instalasi pengolahan air di Cikokol (Tangerang) dan Serpong, masing-masing sebanyak lima dan tiga lokasi. Sebanyak 21 parameter dianalisis, kemudian dihitung Individual Index *(II) dan* Pollution Index *(PI) - nya.*

Hasil yang diperoleh, yang menggambarkan kualitas pencemaran air sungai Cisadane pada saat itu, adalah sebagai berikut :

1. *Tangerang, PI = 1891. Pencemar utama adalah fenol, dengan II = 110 dan lemak & minyak, dengan II = 2670.*
2. *Serpong, PI = 574. Pencemar utama adalah fenol, dengan II = 810*
3. *Parameter lain yang mempunyai II > 1 adalah oksigen terlarut, fosfat, zat besi, fecal coli, nitrat, COD dan zat padat tersuspensi. Hasil tersebut menggambarkan bahwa sungai Cisadane telah tercemar oleh limbah industri dan rumah tangga, serta mungkin pula telah tercemar oleh limbah pertanian, peternakan dan perbengkelan.*

INTRODUCTION

Bogor, Tangerang, Bekasi Urban Development Project (Botabek UDP) is located in kabupatens of Bogor, Tangerang and Bekasi. The Project has some sectors such as sanitation, drainage, and water supply. The main purpose of the Botabek UDP water supply sector is to improve facilities and services of the water supply system in these kabupatens.

In kabupaten of Tangerang, the Cisadane River is used as raw water source for Serpong and Tangerang Water Supply Systems. However, bankside residents use the rivers as their waste disposal site. Along the river are also located many industries which might also

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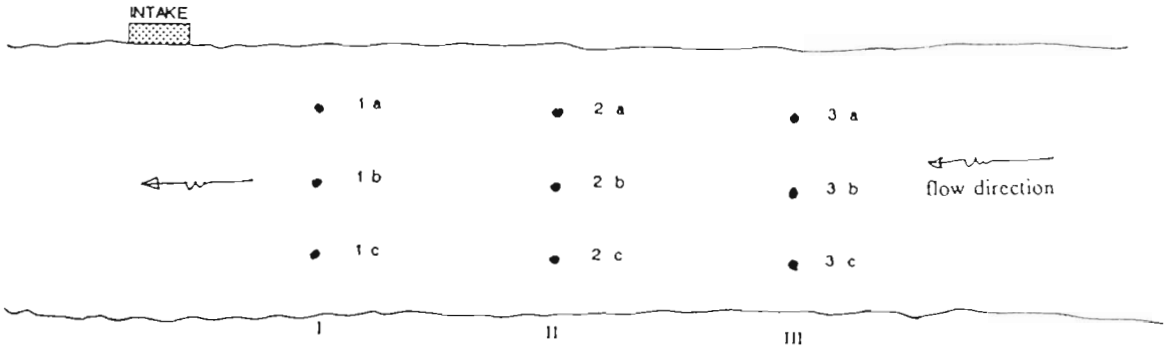
dispose their waste into the river without adequate treatment.

To give an idea on the river water quality as related to its pollution at that moment, a survey was conducted in September 1992. Pollution Index will be used as a tool in determining the quality of pollution.

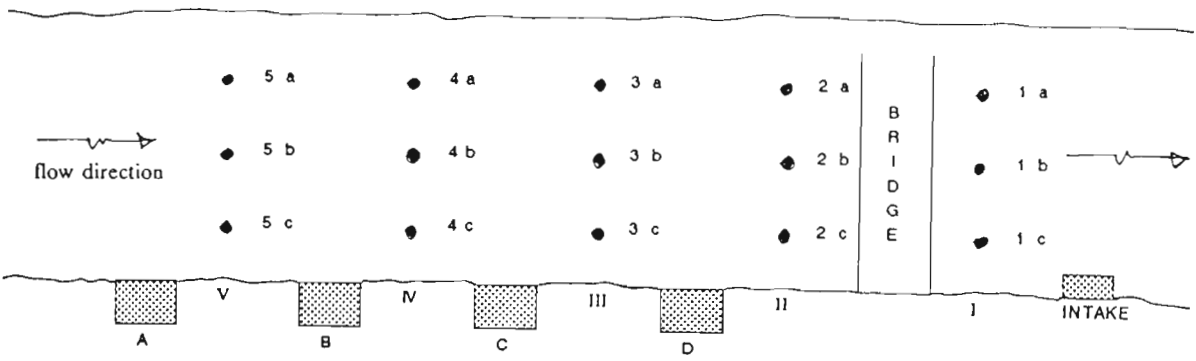
MATERIALS AND METHODS

Sampling location. Three and five sampling locations were chosen in Serpong and Tangerang, respectively. All of them are located before intake of Serpong and Tangerang Water Treatment Plants (WTPs). The sampling locations are shown in Figure 1 and Figure 2.



Note : 1. Intake – location I : ± 20 meters
2. Location I – II, and II – III : 500 meters.

Figure 1. Sampling locations in Serpong (unscaled).



Note : 1. A, B, C, D, : Industries.
2. Location II, III, IV, V : after industrial waste disposal.

Figure 2. Sampling locations in Tangerang (unscaled).

Sample collection. Composite samples from each location were obtained by collecting grab samples at three different sampling points across the river ; one in the middle and two at the river's edge. The samples were only collected once. Samples for chemical and physical analyses were collected in 1000 cc plastic bottles. For metal analyses, samples were collected in 500 cc glass bottles and preserved with HNO3. Samples for fecal coli analyses were collected in 500 cc sterile bottles. All samples were iced and transported to the laboratory for analysis.

Samples analyses. Temperature, turbidity, pH and dissolved oxygen (DO) were determined in the field using TOA Aquamate Water Quality Checker. The laboratory of Directorate General of Human Settlements, Ministry of Public Works, in Bekasi was responsible for physical and chemical analyses; fecal coli were analyzed by the Technical Institute of Environmental Health, Ministry of Health, in Jakarta.

Individual Index and Pollution Index. Individual Index (II) mentioned in Table 1 dan Table 2 shows a relative pollution contributed by a single parameter. The II calculation is based on the same item of the current standard in Indonesia.

$$II = \frac{Parameter\ concentration}{Permissible\ level}$$

The II equation mentioned above needs some modification in two cases, i.e :

- for parameter which decreases in value as pollution increases, such as transparency and dissolved oxygen.
- for parameter which has a range for its permissible level such as pH.

Pollution Index (PI) is a numerical expression of pollution level which is recomended for general uses and administrative purposes, and as a communication mean with the public. The PI derived from IIs is as outlined below.

$$PI = \sqrt{½} \cdot \sqrt{Max.\ II^2 + Mean\ II^2}$$

PI < 1 : the water is below the critical condition

PI = 1 : the water is in the critical condition

PI > 1 : the water requires some treatment prior to the use for specific purpose.

The PI in this paper was calculated for the river used as raw water source only, and it did not reflect damages due to the pollution. The higher the PI value is, the higher the river water pollution and the worse the river water quality.

RESULT AND DISCUSSION

General. As mentioned in Table 1 and Table 2, twenty-one parameters were analyzed and each II was calculated. The current Indonesian and DKI Jakarta standards on raw water sources were used as references.

Table 1. Parameter's Concentration and Individual Index of the Cisadane River water in Tangerang.

No.	Parameter	Concentration	Standard	Individual Index
1.	Temperature, ^{0}C	29.47	Normal t.	0.98
2.	Turbidity, mg/l	253.33	150 NTU	–
3.	pH	5.87	5 – 9	0.565
4.	DO, mg/l	2.28	> = 6	3.58
5.	BOD5, mg/l	7.46	10	–
6.	COD, mg/l	20.90	20	1.045
7.	Suspended Solids, mg/l	112.80	150	0.752
8.	Phosphate, mg/l	1.22	0.5	2.44
9.	Nitrite, mg/l	0.025	1.0	0.025
10.	Nitrate, mg/l	37.00	10	3.70
11.	Iron, mg/l	7.95	5.0	1.59
12.	Manganese, mg/l	0.213	0.5	0.426
13.	Cadmium, mg/l	0.0018	0.01	0.18
14.	Chromium, mg/l	0.003	0.05	0.06
15.	Nickel, mg/l	0.0167	0.10	0.167
16.	Lead, mg/l	0.0009	0.10	0.009
17.	Zinc, mg/l	0.0257	5.0	0.005
18.	Mercury, mg/l	Undetectable	0.001	–
19.	Phenol, mg/l	0.22	0.002	110
20.	Grease & Oil, mg/l	2.67	0.001 *	2670

Note : * For calculation & discussion
** As Standarized.

Mean Index	= 155.37
Maximum Index	= 2670.00
Pollution Index in Tangerang	= 1891.00

Table 2. Parameter's Concentration and Individual Index of the Cisadane River water in Serpong.

No.	Parameter	Concentration	Standard	Individual Index
1.	Temperature, ^{0}C	26.22	Normal t.	0.874
2.	Turbidity, mg/l	377.78	150 NTU	–
3.	pH	5.40	5 – 9	0.80
4.	DO, mg/l	2.95	> = 6	3.12
5.	BOD5, mg/l	1.60	10	–
6.	COD, mg/l	13.17	20	0.66
7.	Suspended Solids, mg/l	153.00	150	1.02
8.	Phosphate, mg/l	1.10	0.5	2.20
9.	Nitrite, mg/l	0.012	1.0	0.012
10.	Nitrate, mg/l	8.87	10	0.887
11.	Iron, mg/l	15.82	5.0	3.164
12.	Manganese, mg/l	0.374	0.5	0.748
13.	Cadamium, mg/l	0.0021	0.01	0.21
14.	Chromium, mg/l	undetectable	0.05	–
15.	Nickel, mg/l	0.0039	0.10	0.039
16.	Lead, mg/l	0.0045	0.10	0.045
17.	Zinc, mg/l	0.0144	5.0	0.003
18.	Mercury, mg/l	undetectable	0.001	–
19.	Phenol, mg/l	1.62	0.002	810

Mean Index = 51.70
Maximum Index = 810.00
Pollution Index in Tangerang = 574.00

Parameter concentration mentioned in the tables is the mean value of the samples.

Two parameters, BOD and turbidity, were not included in calculating the PI. Samples for BOD were not collected properly and the results were doubted; and turbidity unit of the samples and the standard was different.

To avoid difficulty, II for grease and oil was calculated using 0.001 mg/l reference instead of 0.00 mg/l as standardized.

It can be seen that the PI value of Tangerang (1891) is higher than Serpong (574). It indicates that the river water in Tangerang is more polluted than that in Serpong.

Parameters with extremely high II. Two parameters i.e phenol and grease & oil have extremely high II. Phenol occurs in both Serpong (II = 810) and Tangerang (II = 110) sampling locations, and grease & oil (II = 2670) occurs in Tangerang only.
Industries located along the Cisadane River are almost certain the source of phenol. However, grease & oil may come from the industries, garages, or restaurants.

According to Nemerow[1], the phenol limit is set because of the undesirable taste which often results from chlorination of water. Concentrations of phenol which are injurious to health are several thousand times that of the standard established for taste. At Serpong and Tangerang WTPs, chlorine is applied to disinfect the water. Therefore, to prevent undesirable taste of water, the level of phenol in Cisadane river should be maintained as standarized.

Parameters with II > 1, occured in both locations. Four parameters, excluding phenol which mentioned above, have II 1 in both locations. These include DO, phosphate, iron (Fe), and fecal coli. It indicates that the river water in both locations has been polluted by oxygen - demanding substances, phosphate, Fe and fecal coli.

Oxygen - demanding substances may be originated from either human or industrial wastes. These wastes will consume oxygen for their decomposition and decrease the DO of the river.

Domestic wastewater is relatively rich in phosphorus compounds. This was contributed by human wastes or household detergents as well. Besides, phosphorus (phosphate) may also come from heavily fertilized fields, industrial waste, or natural sources such as mineral formation.Plentiful phosphorus can cause algal blooms which may produce nuisance conditions.

Iron in a river may originate from industrial waste. As far as is known, humans suffer no harmful effects from drinking waters containing iron. However, iron can interfere laundering operation, cause spots and stains on white goods, and cause difficulties in distribution systems by supporting iron bacteria growths. To meet the drinking water standard, high concentration of Iron in the Cisadane River needs efficient treatment.

The high II of fecal coli indicates that the Cisadane River water is polluted by feces. It is almost certain that the fecal coli comes from human feces which is discharged directly or indirectly to the river.
Reason for higher number of fecal coli in Serpong (II = 3.5) compared to that in Tangerang (II = 1.2) is not clear. Logically, the number of fecal coli in Serpong must be lower than that in Tangerang, since Tangerang is more crowded than Serpong. However, more industries are located upstream of Tangerang intake than that upstream of Serpong intake. These industries may dispose their toxic-containing wastes which killed the fecal coli or any other bacteria in the river. Some other reasons such as careless sample handling, are also possible.

Parameters with II > 1, occured in one location. Three parameters with II > 1 i.e. suspended solids, and COD and nitrate were found in Serpong and Tangerang, respectively.

Suspended solids may come from domestic and industrial wastes, and erosion in the river watersheds.

The COD is an indication of pollution by domestic and industrial wastes.

Nitrate may originate from domestic and industrial wastes, and fertilizers used. According to Sawyer & Mc Carty[2], waters that contained mostly nitrate nitrogen were considered to have been polluted a long time previously and therefore offered little threat to the public health.

CONCLUSIONS

1. The Cisadane River has been polluted mainly by domestic and industrial waste.
2. The Cisadane River water in Tangerang is more polluted than that in Serpong according to its PI.
3. In both area, phenol contributes high number of II i.e 110 in Tangerang and 810 in Serpong.
4. In Tangerang, grease & oil contributes the highest number of II, that is 2670.
5. The PI in Serpong affected mostly by phenol, however, in Tangerang affected mostly by phenol and grease & oil.

RECOMMENDATION

1. Law enforcement on waste disposal by the Government should be applied to all industries as soon as possible.
2. Intensified public information on proper domestic waste disposal site, especially to the river bankside residents.
3. Intensified public information on river water pollution, especially to the staff of the industries. This including sources of the pollution and its effects on health and environment.

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