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CLEAN RIVER PROGRAM AT KALIGARANG CENTRAL JAVA PROVINCE[1]

(Program Kali Bersih di Kaligarang, Provinsi Jawa Tengah)

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Abstract

Kaligarang River that located in Central Java Province represents one of the rivers in Indonesia which water quality was proved very bad. Since 1989 Clean River Program has been executed in this river. Nevertheless, until 1998 there have not yet independent evaluation towards this program. To know wether of this program successful a survey has been conducted from November 1998 to November 1999. The success of this program investigated by: (1) reducing of pollutant loads, (2) target of pollution loads that reached, and (3) improving of river water quality. It was found that this program has been successfully reducing pollutant loads of waste of all factories as target groups. Nevertheless, the quality of water of Kaligarang River was still relatively bad. This condition probably was cause by domestic waste particularly from hospital, hotel, restaurant and small factories that was not included as target group in this program. Thus it was conclude at he implementation of The Clean River Program in Kaligarang has not been succesful to improve water quality of this river.

Key words: successful of Clean River Program, evaluation studies, river water quality.

Abstrak

Sungai Kaligarang yang terletak di provinsi Jawa Tengah merupakan salah satu sungai yang kualitas airnya dinyatakan buruk oleh pemerintah. Oleh karena itu, sejak tahun 1989 sungai ini dijadikan sebagai salah satu obyek Program Kali Bersih. Namun sampai dengan tahun 1998 belum ada penelitian independen yang mengevaluasi keberhasilan program tersebut. Untuk mengetahui keberhasilan program tersebut, penelitian telah kami lakukan sejak November 1998 sampai November 1999. Keberhasilan program tersebut kami ukur melalui: (1) penurunan beban pencemaran yang masuk ke sungai, (2) pencapaian target kondisi akhir beban pencemaran, dan (3) peningkatan kualitas air sungai yang bersangkutan. Hasil penelitian ini menunjukkan bahwa program tersebut telah berhasil menurunkan beban pencemaran limbah dari perusahaan industri yang menjadi sasarannya. Akan tetapi program belum berhasil meningkatkan kualitas air sungai Kaligarang. Kesimpulannya pelaksanaan Program Kali Bersih di Kaligarang belum berhasil memperbaiki kualitas sungai tersebut.

Kata kunci: keberhasilan program Kali Bersih, studi evaluasi, kualitas air sungai

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INTRODUCTION

The river waters that are dirty, odor; contaminated and polluted are some issues that occurred in last time, primary in big cities. Leopold *et al.* (1990) proves that the condition is something factor that limited water supply in some region in the world. The water that can direct use more and more decreased. Global outlook 21 century represent initiation water crisis century more and more as to reality (Haryoguritno, 1998). In the other hand, global water demand continuously increase according to population grows (see Meybeck *et al. in* Boon, P.J., 1992) (Table 1). The increase of peoples life standard also increase water demand (Saeni, 1989). Thus, water resources management will be increasingly important (see The World Bank, 1994).

The decrease of river water quality as mentioned above can cause wide effect, especially for population in big cities, even affect national interest. If not exceeding, the problem will seriously disturb the national development. Polluted river water can arise some disease (waterborne disease) like cholera, gastroenteritis, typhus, paratyphoid, hepatitis A, and intestinal parasitic infection (see The World Bank, 1994).

According to river water quality decrease as that mention above, since 1989 Indonesia government executed Clean River Program (Program Kali Bersih = Prokasih). The government of the Republic of Indonesia defined Kaligarang river being the object this program in Central Java province. The main purpose of this program are: (1) to reduce the pollution load discharge to the river, and (2) to improve the river water quality. However, until 1998 external evaluation that independently evaluate of this program was not yet carried out. To know the success of this program and quality of water of Kaligarang River, this study was conducted. Result of this study was expected as an information contribution to Indonesia government i.e. The Environmental Impact Management Agency (Badan Pengendali Dampak Lingkungan) as Clean River Program executor.

METHODOLOGY

This study has been carried out in Kaligarang River, Central Java province (see Figure 1) since November 1998 until November 1999. This river represent anything river in Indonesia that its water quality proved very bad, so that it was a prepared as Clean River Program object since 1989.

Variables investigated are: (1) quality of effluent (industrial waste that for discharge into environment) from all target groups - eight factories, (2) success of The Clean River Program, and (3) quality of water of Kaligarang River. The quality of effluent investigated with three parameters are: (1) BOD (Biochemical Oxygen Demand), (2) COD (Chemical Oxygen Demand), and (3) TSS (Total Suspended Solid). The success of the Clean River Program investigated with three parameters, are: (1) reduc of load pollution, (2) target of pollution load reached, and (3) improving of river water quality. The quality of the water of Kaligarang River measured was some physical, chemical and biological parameters. Some parameters representing primer data (direct measured) and some parameters represent secondary data that source from Local Environmental Impact Management Agency[2].

The BOD is measured with a 5-day period technique (BOD_5), the COD measure by bichromate technique, and the TSS was measured by gravimetric. The pollution load of waste was obtaining by producing quality of waste with mean of waste debit per day.

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[2] That agency executes monthly monitoring at five stations – monitoring station 1, 2, 3, 4 and 5

Table 1. Trends in global water consumption by major category, $km^3 a^{-1}$

Water usage	1900	1950	1970	1990	2000
Agriculture	525	1 130	1 850	2 680	3 250
Industry	37	178	540	973	1 280
Municipal needs	16	52	130	300	441
Reservoirs	<1	7	66	170	220
Total	579	1 367	2 586	4 123	5 191
Increase	-	788	1 219	1 573	1 068
		(136.10%)	(9.17%)	(59.44%)	(25.9%)

Source: Global Environment Monitoring System Global Fresh-water Quality: A First Assesment, 1989. Meybeck, M., Chapman, D., and Helmer, R. Oxford: Basil Blackwell Ltd. pp. 306. Adapted and modified from Boon, 1992.

Samples of waste taken from eight target factory, they are: (1) three galvanize industries, (2) two pharmacy industries, (3) one textile industry, (4) one ceramic industry, and (5) one concrete industry. The samples were taken on March 1999. Analysis of the samples was conducted in Board of Research and Development for Industry (Balai Penelitian dan Pengembangan Industri) of Central Java province in Semarang. Besides that, so was take secondary data - result of internal monitoring from The Local Environmental Impact Management Agency.

To know the water quality of the Kaligarang river, water samples of that river was taken from four observatory-station, that are: KA_1, KA_2, KA_3 and KA_4. KA_1 station represents industrial and residential area, KA_2 station located in residential, agricultural, breeding, and sand mining area, KA_3 station represent industrial, agricultural and breeding area and the last, KA_4 station located in plantation, forestry, agricultural and breeding area (see Figure 2). The samples from all station were taken three times repetitions that are in December 1998, January and February 1999. The samples was analyzed in: (1) oard of Research and Development for Industry of Central Java province in Semarang, and (2) The Environment Research Center, Bogor Institute of Agricultural (Pusat Penelitian Lingkungan Hidup Institut Pertanian Bogor).

Analysis of waste that source from target groups of the Clean River Program executed by comparing quality of those waste (result of laboratories analysis) towards Quality Standard of Industrial Waste (Appendix of Decree of The Minister of State for Environmental of The Republic of Indonesia Number KEP-51/MENLH/10/1995 concerning Control of Water Pollution) (Badan Pengendali Dampak Lingkungan, 1997) and Decree of Governor of The Central Java Number 660.1/02/1997 concerning quality standard of liquid waste (Keputusan Gubernur Jawa Tengah No. 660.1/02/1997 tentang baku mutu limbah cair) (Anonym).

The successful of the Clean River Program to reduce pollutant loads executed by comparing previous loads, i.e. pollutant loads when program was starting (in 1989) towards recent loads, i.e. pollutant loads when the study executed (in 1998/1999). The successful presented in percentage. While, the successful of the Clean River Program to reach target of reduce pollutant loads executed by comparing recent loads towards target.

The target of the recent pollutant loads is according with Decree of The Minister of State for Environmental of The Republic of Indonesia Number KEP.03/MEN-KLH/II/1991. As for the successful of the Clean River Program to increase quality of water of

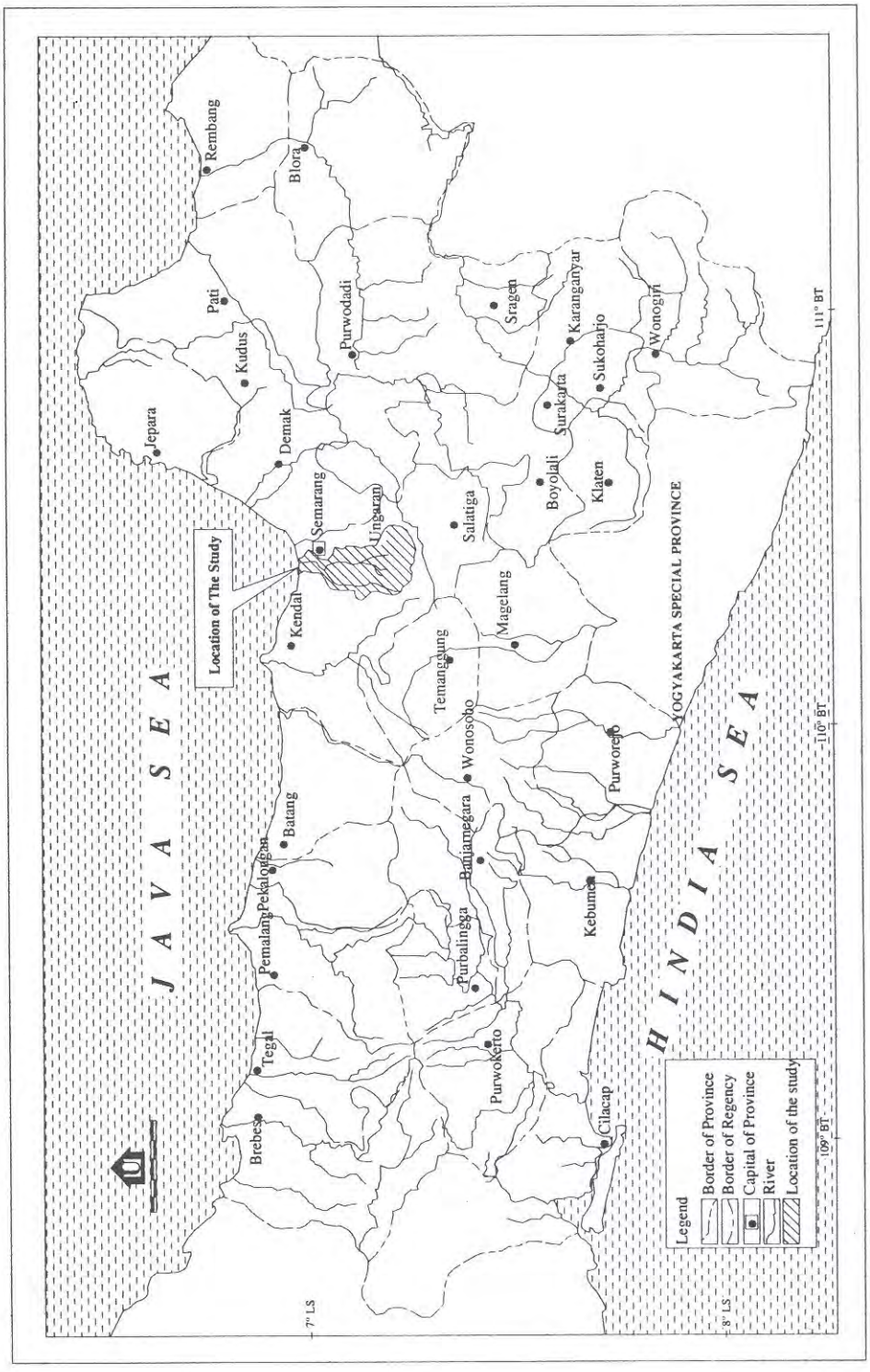

Figure 1. Location of The Study

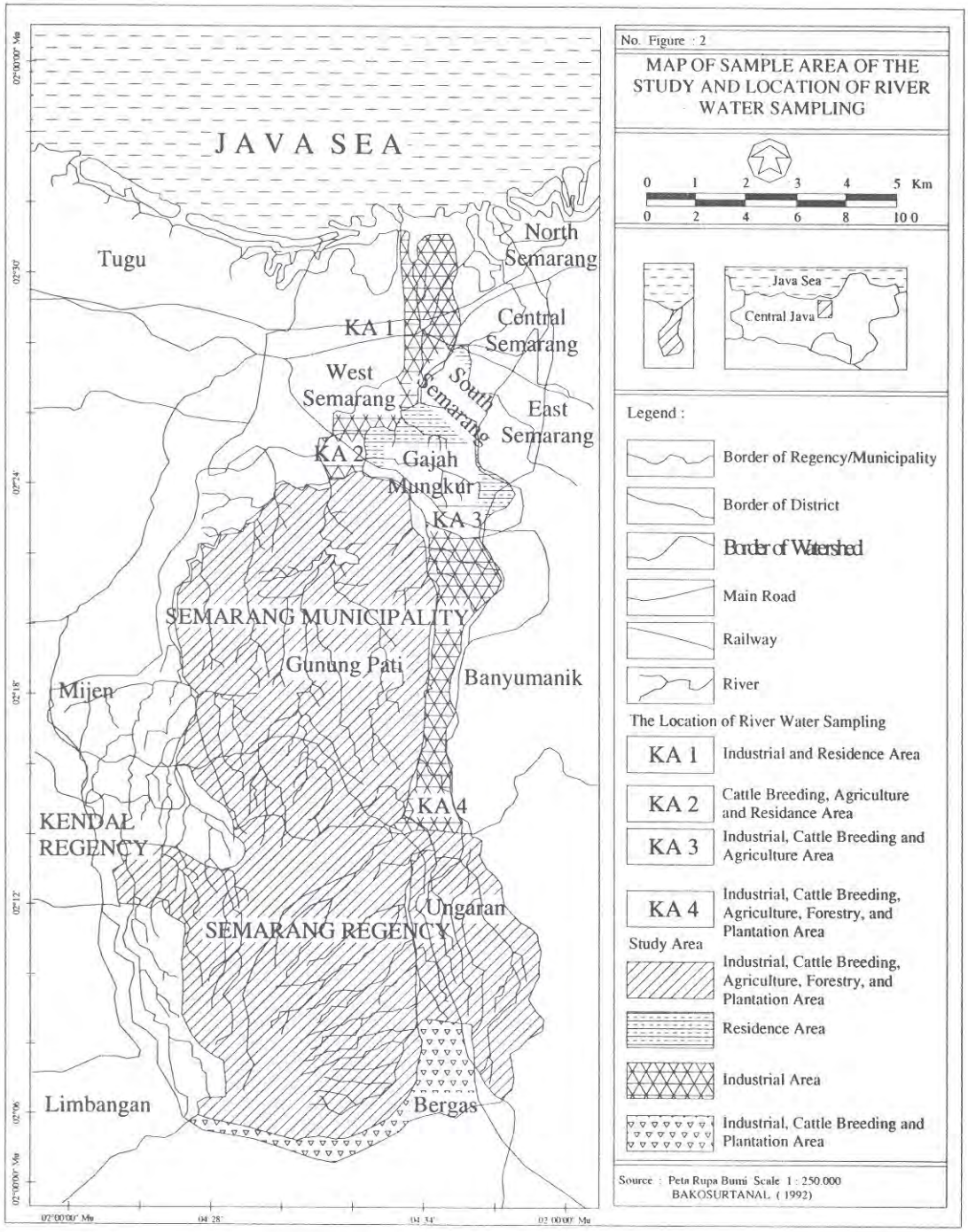

Figure 2. Samples area of The Study and Location of River Water Sampling

Kaligarang river execute by to look for change of three key parameters, i.e. reduce of BOD and COD level and increase of DO level since initiation program execute.

Evaluation on quality of the water of the Kaligarang river execute by comparing some parameters – physical, chemistry and biology as result of analysis of samples water (primer data) and secondary data towards standard of water quality of United Nations Educational, Scientific and Cultural Organization (UNESCO), World Health Organization (WHO), United Nations Environment Programme (UNEP) (1992), European Community (EC) and quality standard of water according Government Regulation of The Republic of Indonesia Number 20 of 1990[1] (Badan Pengendali Dampak Lingkungan, 1997). Importantly to know that the water of this river so far use for raw material of drinking water, fishery, cattle breeding, agricultural, urban activities, and industries by peoples.

RESULTS AND DISCUSSION

Successful of Clean River Program in Kaligarang

Clean River Program that executed in Kaligarang River during 10 years ago has been reducing pollutant loads of waste of target groups. BOD, COD and TSS level of waste that discharge into this river by target groups can be reducing severally 97.70%, 97.85% and 99.18%. Reached of recent loads target severally 846.16%, 465.29% and 112.32%. Although generally pollutant loads can be reducing, but it is still fluctuate annually. This fluctuate never beyond the previous pollutant loads, but the fluctuate to have that beyond recent pollutant loads target, especially in early program execute (see Table 2 and Appendix 1). Beside that, just 50% of target groups, i.e. four factories that quality of the waste met to quality standard of industrial waste according Decree of The Minister of State for Environmental of The Republic of Indonesia Number KEP-51/MENLH/10/1995 (see Appendix 2).

The Clean River Program was successful on reduce pollutant loads of waste, but the program not yet to improve quality of water of the Kaligarang river. The water of this river still relatively badness. The BOD level of water of the river not decrease relatively (see Appendix 3). Even BOD level increase frequently, especially at last execute of phase I program (years X). At almost all monitoring-station (80%) found that increases of BOD level beyond threshold level of quality standard of water for life aquatic by European Community, i.e. 3.0 – 6.0 mg/l. This conditions probably also cause by flood that bring contaminant from terrestrial. The big flood in this river occurs among other things in 1988, 1990 and 1993 (Japan International Cooperation Agency, 1993 and Perez *et al.*, 1998).

So, COD level of the water of this river not decrease relatively, this parameter still high (see Appendix 4). This condition probably more causes by flood that occurred in 1990 and 1993. In Appendix 3 and Appendix 4 seen that the level of the COD always more than level of the BOD.

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[1] This regulation classified water into four categories, i.e. A, B, C and D.
Water A category that is water quality that can use as drinking water directly, without treatment.
Water B category that is water quality that can use as raw material of drinking water.
Water C category that is water that can use for fishery and cattle breeding.
Water D category that is water that can use for agricultural, urban activities, industries, and electric generator or power plant.

Table 2. Change of Pollutant Loads that to enter into Kaligarang River by Target Factories during 1- years Clean River Program executed

Parameter	BOD	COD	TSS
Previous Condition	146.933	447.737	958.843
Year I	139.748	441.809	802.681
Year II	55.183	116.802	914.426
Year III	118.716	30.818	404.089
Year IV	76.011	125.022	11.804
Year V	11.097	265.125	176.056
Year VI	53.161	11.584	129.691
Year VII	40.872	11.275	59.346
Year VIII	17.912,59	51.608,00	45.167,00
Year IX	18.030,12	47.706,57	36.762,44
Year X (Recent condition)	3.376,62	9.637,14	7.850,22
Target (Final Condition)	129.967 44	353.580,00	112.181 95
Reduce of Pollutant Loads (%)	97,70	97,85	99,18
Reach on target (%)	846,16	465,29	112,32

Explanation: unit for all parameter is kg/year

$$\text{Reduce of BOD} = \frac{146\,933\,000 - 3\,376{,}63}{146\,933\,000} x\,100\% = 97{,}7\%$$

$$\text{Reduce of COD} = \frac{447\,737{,}00 - 9\,637{,}14}{447\,737\,00} x\,100\% = 97{,}85\%$$

$$\text{Reduce of TSS} = \frac{958\,843\,00 - 7\,850{,}22}{958\,843{,}00} \text{x}\,100\% = 99{,}18\%$$

$$\text{Reduce of BOD target} = \frac{146\,933\,000 - 3\,376}{146\,933\,000 - 129\,967{,}44} \text{x}\,100\% = 846{,}96\%$$

$$\text{Reduce of COD Target} = \frac{447\,737{,}00 - 9\,637{,}14}{447\,737{,}00 - 353\,580{,}00} \text{x}\,100\% = 465{,}29\%$$

$$\text{Reduce of TSS target} = \frac{958\,843\,00 - 7\,850{,}22}{958\,843{,}00 - 112\,181{,}95} \text{x}\,100\% = 112{,}32\%$$

Source of data: Regional Environmental Impact Management Agency of Central Java Province (Bapedalda/Tim Prokasih Jawa Tengah). 1999

This condition generally occur in aquatic environment, because aquatic environment amount of the chemical compose that can chemically oxidation more than chemical compose that can biologically oxidation.

As much two parameters previously, the DO level of water of this river not increase significantly. But, in great number of the monitoring-station (60.00%), i.e. station 1, 2 and 3 since early program execute the DO level had above of threshold level of standard of water quality for life aquatic by European Community, i.e. 5.6 – 9.0 mg/l (see Appendix 5).

So that concludes that the Clean River Program at Kaligarang river has decrease pollutant load from the target group which discharge to this river, but this program not yet increases quality of the water of this river. Still constantly high of BOD and COD level of this river water probably cause by domestic waste (hospital, hotel and restaurant that not yet include as target group of this program), because BOD level of the waste domestic usually relatively high - 300 – 350 mg/l (Burke, 1972). Beside that, that condition probably so cause by industrial waste of some factories, which not yet include as target group, especially in Semarang Regency (Kabupaten Semarang). In this region found some factories that potentially environment polluted, i.e. three textile factories, four soft drink factories, biscuit, pharmacy and some else factories.

Those can say that Clean River Program at Kaligarang river not yet success to improve water quality of this river primary cause by numerous factories and people that not yet include as target group. The else reason for still relatively lower quality of the water of Kaligarang river may be source from urban surface runoff, because the BOD level of the urban surface runoff can be reach 10 – 250 mg/l (Burke, 1972).

Quality of the Water of the Kaligarang River

Generally conclude that along 10 years Clean River Program execute in Kaligarang river, quality of the water of this river still bad constantly. BOD and COD level of the water of this river still high constantly. Beside that, was found that the level of some else parameters also not yet to meet the standard of water quality or fluctuate around threshold level of the standard. In Table 3 can se that the level of turbidity, fecal Coliforms and total Coliforms of all – four - observatory-station on all water sample more beyond maximum level that agree by WHO either European Community for drinking water. The high of the level of the fecal Coliforms suppose also cause by domestic waste (including feces), because was found that some peoples (15,45%) to have motions in the river. While, suppose that highly turbidity of the water of this river cause by agricultural and sand mining activities. Level of pH of the water of this river tend to beyond of the quality standard of the water that use, especially by WHO, EC and USA.

Level of some another parameters – TSS, mercury, cadmium, zinc, phenol and sulfide – in all observatory station and along time fluctuates around threshold level of the standard of water quality by EC, WHO either USA (Table 3). Highly level of TSS in downstream observatory station – KA_1 - presumed as impact of industries activities, because that observatory station located in industrial area, included freshwater industry (Perusahaan Daerah Air Minum) that discharge they waste into the Kaligarang River. As well as, presume that highly level of mercury, cadmium, zinc, and sulfide in this station was derived from industries activities in this area. Level of oil and grease in the water of Kaligarang river also not yet to meet quality standard of water B category agree with use of the water of this river as raw material of drinking water to (Table 3).

Table 3. Some Parameters of Water of Kaligarang River that not yet to meet Water Quality Standard and some parameters that still fluctuate around Threshold Level of Water Quality Standard. Samples of water were taken at December 1998, January and February 1999 from four stations.

Parameters	Observatory Station				Water Utilities					
					Drinking Water				Aquatic Life	
	KA_1	KA_2	KA_3	KA_4	WHO	EC	USA	Indonesia[4]	EC	Indonesia[5]
BOD (mg/l)	4.440	2.030	3.590	3.970	-	-	-		3.0 - 6.0	-
	2.380	2.900	33.340	4.430						
	7,040	4.570	5.270	4.290						
Mercury (Hg)[*] (mg/l)	13.71×10^{-3}	2.542×10^{-3}	1.492×10^{-3}	4.475×10^{-3}	0.001	0.001	0.002	0.001	-	0.002
	0.045×10^{-3}	0.238×10^{-3}	0.191×10^{-3}	0.118×10^{-3}						
	0.045×10^{-3}	0.238×10^{-3}	0.191×10^{-3}	0.118×10^{-3}						
Phenol (mg/l)	0.0000	0.0000	0.0000	0.0000	-	0.0005	-	0.002	-	0.001
	0.0032	0.0000	0.0000	0.0006						
	0.0060	0.0000	0.1777	0.0000						
Sulfide (H_2S) (mg/l)	0.4212	0.4301	0.0903	0.0000	-	-	-	0.1	-	0.002
	0.0335	0.0000	0.0022	0.0000						
	0.0958	0.0000	0.1946	0.0000						
Oil & Grease	0.0000	0.0000	0.0000	0.0000	-	0.01	-	0	-	1
	0.0019	0.0019	0.0023	0.000						
	0.0023	0.0015	0.0000	0.0000						
Cadmium (Cd)	0.0013	0.0013	0.0044	0.0009	0.005	0.005	0.01	0.018	-	0.01
	0.0179	0.0067	0.0022	0.0022						
	0.0450	0.0084	0.0073	0.0056						

[4] Used quality criterion of water B category that is water that can use as raw material of drinking water to agree with utilization of the water of this river.

[5] Used quality criterion of water C category that is water that can use for fishery and cattle breeding.

[*] According with Decree of Governor of The Central Java Province Number 660.1/02/1997 (Anonym).

Table 3 (continued)

Parameters	Observatory Station				Water Utilities					
		Drinking Water			Aquatic Life					
	KA_1	KA_2	KA_3	KA_4	WHO	EC	USA	Indonesia[6]	EC	Indonesia[7]
Zinc	0.048	0.0050	0.0096	0.0052	5.0	0.1 – 3.0	5.0	5	0.03 – 2.0	0.02
	0.0120	0.0108	0.0096	0.0090						
	0.0029	0.0041	0.0065	0.0047						
Fecal Coliforms	$2100x10^3$	$75x10^3$	$21x10^3$	$20x10^3$	0	0	-	$2x10^3$	-	-
(sum/100 ml)	$2400x10^3$	$210x10^3$	$93x10^3$	$75x10^3$						
	$2400x10^3$	$210x10^3$	$93x10^3$	$75x10^3$						
Total Coliforms*	$2400x10^4$	$210x10^3$	$240x10^3$	$93x10^3$	0 - 10	-	1	$10x10^3$	-	-
(sum/100 ml)	$2400x10^4$	$210x10^3$	$150x10^3$	$75x10^3$						
	$2400x10^4$	$210x10^3$	$150x10^3$	$75x10^3$						
TSS (mg/l)	26	90	70	54	-	-	-	-	25	-
	30	22	10	42						
	30	22	10	42						
Turbidity (NTU)	18	11	14	15	5	4 JTU	1 - .5	-	-	-
	27.5	22.5	12.5	22.5						
	27.5	22.5	12.5	22.5						
PH	6.95	7.32	7.73	6.76	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5	5 – 9	6.0 – 9.0	6 – 9
	8.5	8.6	8.8	6.5						
	7.8	7.5	7.0	7.0						

Explanation: KA_1 = observatory station that located in industrial and residential area, KA_2 = observatory station that located in residential, agricultural, and breeding area, KA_3 = observatory station that located in industrial, agricultural, and breeding area, and KA_4 = observatory station that located in plantation, forestry, agricultural, and breeding area.

Source of data : the data that marked * are primer data (result of field survey), and others are secondary data (data from Local Environmental Impact Management Agency as regional Team of Clean River Program of Central Java Province).

[6] Used quality criterion of water B category that is water that can use as raw material of drinking water to agree with utilization of the water of this river.

[7] Used quality criterion of water C category that is water that can use for fishery and cattle breeding.

Level of this parameter that always to met quality standard – null - only found in observatory station that located in upstream area – KA_4. On the contrary, found that the level of this parameter in another three observatory station always over the quality standard. To tend that so much to downstream area, so much higher the level of oil and grease in the water. Highly level of oil and grease in observatory station that located in downstream area presume cause by storm-water runoff from urban areas, especially workshop, car washings, vehicles dripping, and industry, because that observatory station, primary two last – KA_2 and KA_1 – located in underside of center of city and industrial area. Goudie (1981) proved that storm-water runoff from urban areas may contain large amounts of contaminants, derived from litter, garbage, carwashings, horticultural treatments, vehicle drippings, industry, construction, animal droppings, and so on.

CONCLUSION AND RECOMMENDATION

Conclusion

The Clean River Program that was executed during 10 years (1989 – 1998) at Kaligarang River has been reducing pollutant loads of waste of target groups more than 90.00%. Nevertheless, just half of target groups that quality of the waste met to The Standard of Quality of Industrial Waste, and this program not yet could improve the quality of the water of this river. Was found that the BOD and COD level of the water of this river not reduced relatively, and DO level of the water not increased significantly.

Until this study carry out, the quality of the water of this river still relatively bad. The level of BOD, COD, fecal Coliforms, and total Coliforms of the water still relatively beyond the threshold level of the standard of the water quality that defined by WHO, EC, USA either government of Republic Indonesia, for raw material of drinking water either aquatic life according utility of the water of this river by peoples. Beside that, some else parameters - TSS, mercury, cadmium, zinc, phenol, sulfide, and oil & grease – still fluctuates around threshold level the standard of water quality by EC, WHO, USA either The Republic of Indonesia that mentioned above. That condition among other things causes by less of community participation and few group that prepared as target (only eight industrial factory) and not yet involve other group.

Recommendation

To improve community participation in the Clean River Program and improving the quality of the water of Kaligarang River as anything of indicator of the successfully of this program recommended to government to:

(1) Improving and extending socialization of the Clean River Program, because was found that knowledge of the community towards this program represent one of independent variable that affect their participation in the program.
(2) Quickly involve other group that caught in river water as target group of the program like hospital, hotel, restaurant, home industry, and small industry.
(3) Give distinct sanction towards target group of the program that not participate, because was found that their participate dependently on their view towards consequences for a person that participate or not participate.

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Appendix 1. Reduced of pollutant loads (BOD, COD and TSS) of all – eight - industrial factories (as target group) that enter to Kaligarang River during Clean River Program execute (10 years), 1989 – 1998.

Source of data: Regional Team of Clean River Program of Central Java province.

Appendix 2. Result of analysis of waste samples that taken on March 1999 from discharge of eight industrial factories as target group of Clean River Program at Kaligarang

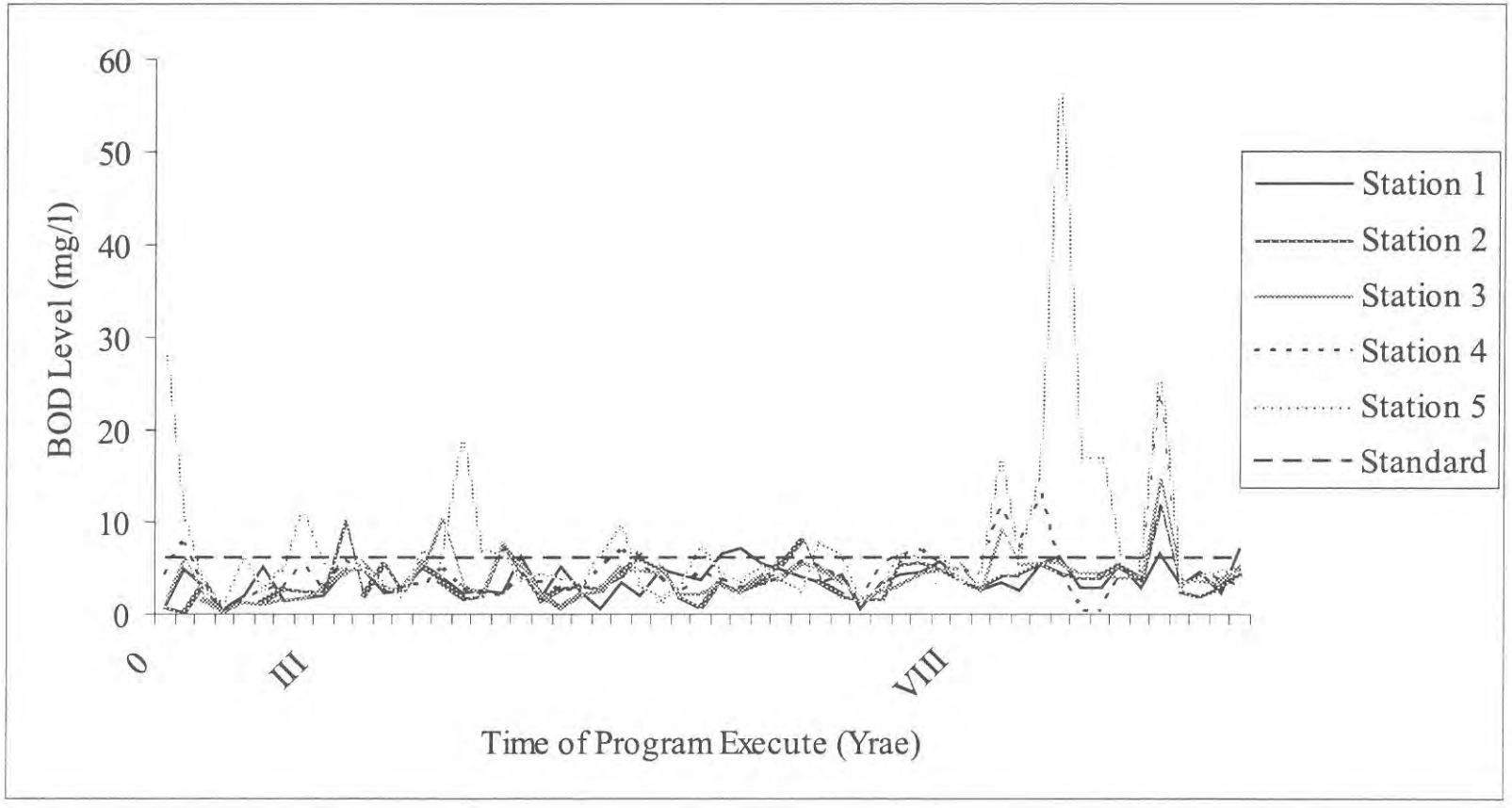
	Factories															
Parameter	I		II[a]		III		IV[a]		V		VI		VII[a]		VIII[a]	
Physical	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]
Temperature (°C)	29		-		33		34		26		28.1		33			
TDS	446	2.0293	16	0.12	664	-	658	71.064	498	35.856	4 866	248.166	1 146	-	48	
TSS	14	0.0637	7.5	-	34	-	18	1.944	28	2.016	16	0.816	20	-	17	0.816
Debit (m^3/day)	4.55		-		110	*reuse*	108		72		51		*reuse*			
Chemical																
PH	7.00		7.00		7.00		7.10		9.82		7.00		7.00		7.00	
Zinc	0.144	0.00065	1.2835	0.009	0.300		0.421	0.0455	0.763	0.0549	1.063	0.0542	0.043			
Chromium hexavalence	0.000	0.000	0.000	0.000	0.000											
Total Chromium	0.0000	0.000	0.0130	0.000	0.000		0.000	0.000	0.000	0.000	0.062	0.0032	0.019		0.035	0.0006
Cadmium	1.959	0.0089	0.000	0.000	0.113		0.053	0.0057	0.160	0.0115	0.154	0.0078	0.039			
Sulfide	0.396	0.0018			0.297		0.000	0.000	0.1265	0.0091	0.0002	0.0000	0.297		0.000	-
Free Ammonia	0.0011	0.0000			0.0048		0.0306	0.0033	0.0015	0.0001	0.1314	0.0067	0.0048			
Total Ammonia															0.0008	-
BOD_5	12.527	0.057	8.20	0.066	6.026		14.133	1.526	10.783	0.7784	13.620	0.6946	1.522		3.806	0.065
COD	37.190	0.1692			16.529		45.455	4.91	24.590	1.7705	16.393	0.8360	24.793			0.35
COD (Chromate)			40.146	0.301												
COD ($KmnO^4$)			17.48	0.131												
Phenol	0.0315	0.00014			0.000		0.0599	0.0055	0.000	0.0000	0.4874	0.0238	0.000			

Appendix 2 (continued)

Parameter	Factories															
	I		II[a]		III		IV[a]		V		VI		VII[a]		VIII[a]	
Chemical	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]	1[b]	2[c]
Total phenol															0.000	0.000
Total oil	0.0000	0.0000	0.0400	0.000	0.0027		0.0000	0.000	0.000	0.0000	0.0023	0.0001	0.0106		0.0039	0.0000
Cooper			0.0605	0.000												
Nickel			0.000	0.000							0.880	0.0449				
Cyanide											0.039	0.0020				
Iron											0.214	0.0109				
Manganese											0.000	0.0000				
Lead											0.049	0.0025				

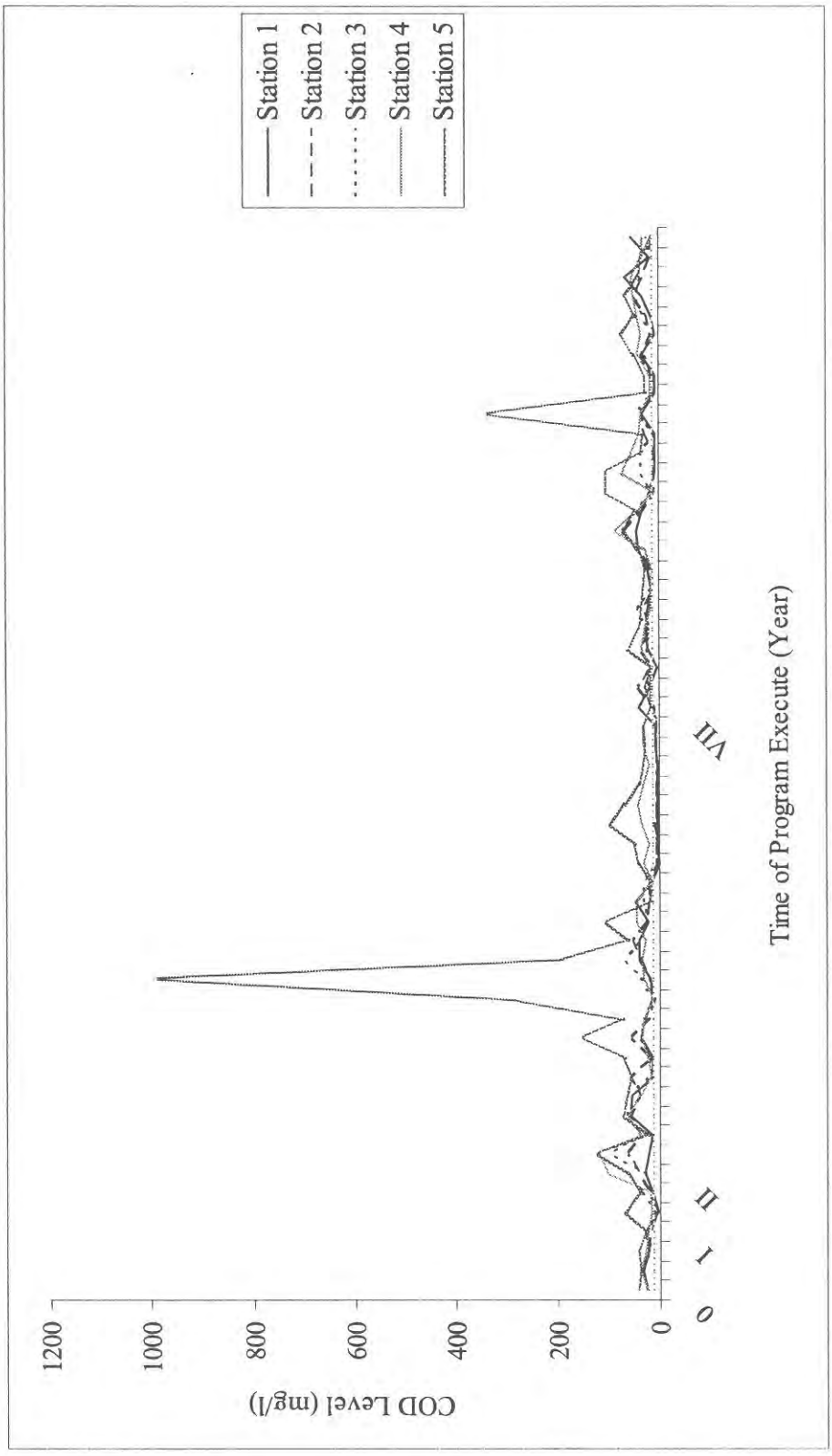
Explanation : Factory I = concrete industry, II, VI and VII = galvanize industry (zinc), III = vegetable oil & limited pharmacy industry, IV = pharmacy (formulation) industry, V = ceramic industry, VIII = textile industry
[a] = the waste discharge of the factories has been to meet The Quality Standard of The Waste Industrial.
1[b] = quality of waste (concentration, mg/l), 2[c] = pollution load of the waste (kg/day)
Samples of waste have been analysis in Board of Research and Development for Industry (Balai Penelitian dan Pengembangan Industri) of Central Java in Semarang.

Source of data : Field survey, 1998 - 1999



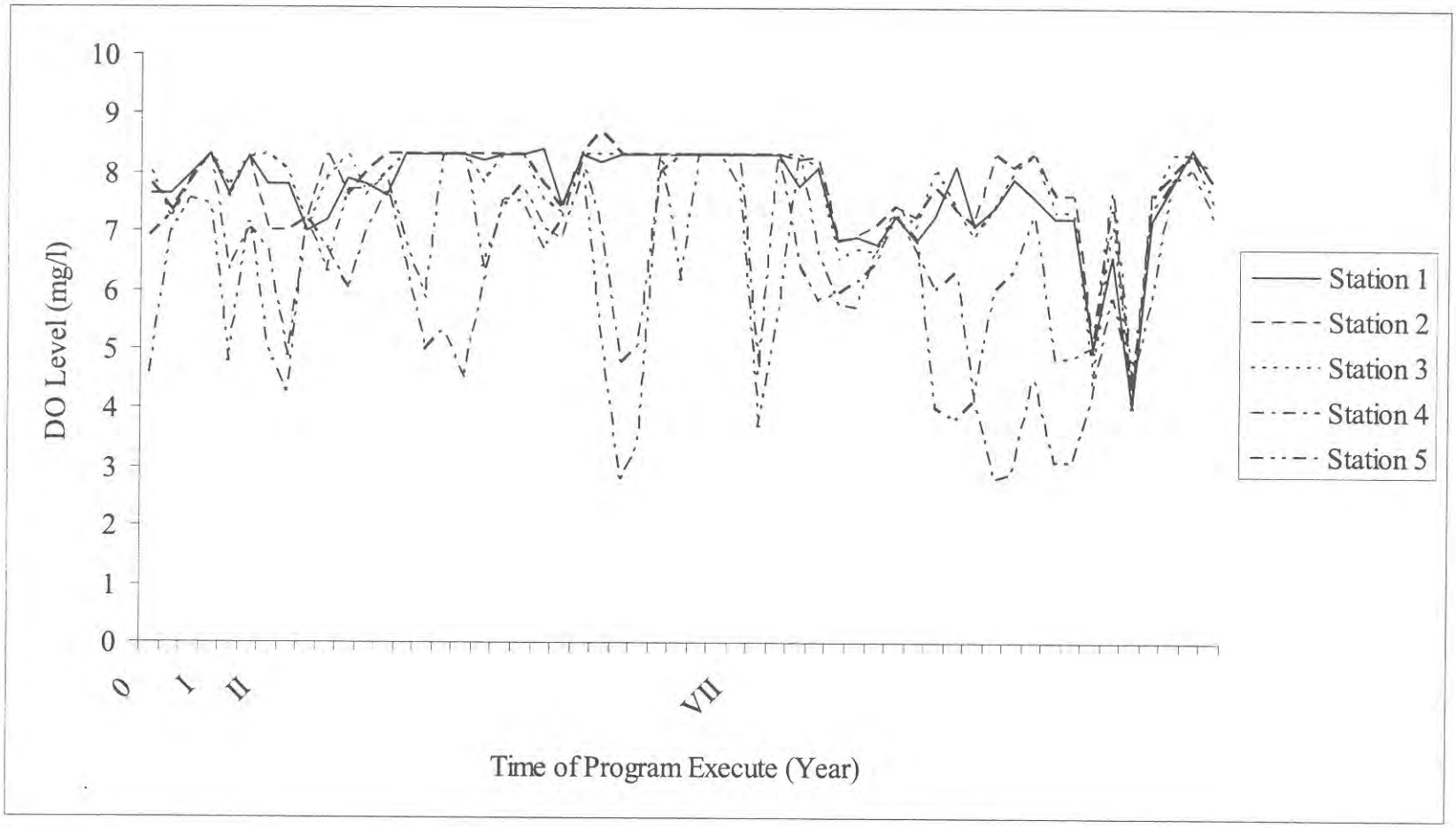
Appendix 3. Change of BOD level of water of Kaligarang River during 10 years execute of Clean River Program, based on samples water which taken from five monitoring station, compare with water quality standard for aquatic life from European Community.

Source of data: Regional Clean River Program Team of Central Java, 1999.



Appendix 4. Change of COD level of water of Kaligarang River during 10 years execute of Clean River Program, based on samples water which taken from five monitoring station.

Source of data: Regional Clean River Program of Central Java, 1999.



Appendix 5. Change of DO level of water of Kaligarang River during 10 years execute of Clean River Program, based on samples water which taken from five monitoring station.

Source of data: Regional Clean River Program of Central Java province, 1999.