REVIEW ON WATER POLLUTION STUDIES IN INDONESIA

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ABSTRAK

Tulisan ini merupakan tinjauan terhadap lebih dari 60 penelitian yang pernah dilakukan di Indonesia yang berkaitan dengan masalah pencemaran air.

Dalam tinjauan ini terungkap bahwa hampir semua jenis sumber air, yaitu sungai, danau, tambak, laut maupun air tanah (misalnya sumur) yang pernah diteliti, telah mengalami pencemaran. Pencemarnya terdiri dari semua jenis pencemar, baik bakteriologis, fisis maupun kimiawi.

Pencemar bakteriologis terutama datang dari pembuangan tinja manusia. Bukan hanya karena letak sumber air yang berdekatan dengan pembuangan tinja yang menyebabkan pencemaran, melainkan juga karena perilaku masyarakat. Namun dicatat pula bahwa penelitian dalam bidang ini masih terlalu sedikit. Khususnya yang berkaitan dengan besarnya masalah.

Pencemar fisis dan kimiawi terutama berasal dari pabrik-pabrik. Yang banyak mendapat perhatian tampaknya adalah logam-logam berat. Walaupun dijumpai kandungan beberapa logam berat dalam air masih di bawah standar, tetapi beberapa yang lain cukup potensial atau telah melewati batas-batas standar dan bahkan telah menimbulkan dampak negatif terhadap kesehatan masyarakat. Hal ini terutama dikarenakan banyaknya pabrik-pabrik yang membuang limbah industrinya langsung ke sungai dan badan-badan air lain tanpa pengolahan terlebih dulu atau dengan pengolahan yang tidak sempurna.

Selain deterjen, sampah rumah tangga, pestisida dan pupuk sebagai pencemar, yang masih kurang mendapat perhatian peneliti, akhir-akhir ini muncul masalah baru yang tampaknya lebih menarik minat para peneliti, yaitu intrusi air laut. Dari beberapa penelitian yang telah dilakukan terungkap bahwa masalah ini pun sudah cukup serius, khususnya di daerah dekat pantai.

INTRODUCTION

Water plays a predominant role in human life. The uses of water by the community include almost all aspects of human life. Daniel A. Okun[1] identifies twelve activities of human being requiring water supply, i.e. drinking and culinary purposes; personal cleanliness, including bathing and laundering; household cleanliness, heating and air conditioning; watering lawns and gardens, cleaning streets, recreational purposes, including swimming pools and the watering of playing fields; amenity purposes, such as public fountains and ornamental ponds; power production from hydropower and steam power; commercial and industrial purposes, including industrial process waters and cooling; fire protection; and carrying away wastes from all manner of establishments.

Water may be abstracted for use from any one of a number of points in its movement through the hydrologic cycle. The most common sources of water are rain water, surface water, and ground water. But for certain purposes, especially

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drinking and culinary, good quality of water is needed. However, in most developing countries, to obtain safe drinking water is still a problem.

Water is abundance in Indonesia. In the mountainous areas or in the areas where ground water and surface water are easy to obtain, people use those kinds of water. At the seashores or in the areas where such waters are difficult to obtain, people use rain and brackish water. But like in any other developing countries, especially in the rural areas, people mostly lack the knowledge in selecting safe water sources. In 1982 a national survey on water supply and sanitation found that 87.8 percent of the household respondents use less and unsafe water supply facilities. Meanwhile, 89,8 percent of them have less and inadequate sanitation facilities[2]. A 1986 national household health survey indicated that 48.6 percent of the respondents use wells water and 20.7 percent use river water for drinking[3]. It was also reported in earlier study that more than fifty percent of people of five villages in West Java use fish pond water for household purposes. Most fishponds are used for defecation and as such they are contaminated with parasites and bacteria[4]. With industrialization program accelerated in Indonesia even physical and chemical water pollution are now penetrating into villages. Even though water is abundance in Indonesia, obtaining safe water sources is getting more difficult due to the increasing water pollutants. Moreover, the lack of knowledge of the people of safe water usage will make the health and sanitation problems even more complicated.

THE QUALITY OF WATER

According to E.G. Wagner and J.N. Lanoix[5], water to be safe for use must meet three standards for water quality. Water should be free from microbiological contaminants, which is determined by the presence of coliform bacterium in the water. The more coliform bacteria to be found in a certain amount of water, the lesser the quality of the water. The physical quality of water is measured by the turbidity, color, odor and taste of the water. Water should also be free from chemical and radioactivity. The chemical contaminants include inorganic chemicals (arsenic, borium, cadmium, chromium, lead, mercury, nitrate, selenium, silver, fluoride) and organic chemicals (chlorinated hydrocarbons and chlorophenoxys). Fair & Geyer[6] described safe water as: (1) uncontaminated and hence unable to infect its user with waterborne disease, (2) free from poisonous substance, and (3) free from excessive amounts of mineral and organic matter.

WATER POLLUTION IN INDONESIA

Review on studies done in Indonesia shows many water pollution cases have occurred. Studies done by Permadi Nurhasan[7] in Magelang, Central Java, by Utomo Hari[8] in Semarang, Central Java and Mojokerto, East Java, and by Soeminarti et al[9,10] in Solo River, Central Java and Brantas River, East Java revealed that the problem is still not serious. However, the result of these studies were based on a few stations for observation.

B.A. Kawengian [11] who studied water

pollution in big cities of Indonesia found that some rivers have been heavily contaminated by heavy metals and other pollutants. Idjah Soemarwoto et al.[12] who studied the quality of water from 350 stations for observation including rivers, lakes, wells, and ponds throughout Sumatera, Java, Bali, Kalimantan, and Sulawesi, concluded that there is no water body which meets the criteria for Grade A stated in the 1975 Minister of Health Regulation.[13] Many chemical substances were found in excessive amount, especially organic chemicals and nitrogen. Study by Sri Soewasti Soesanto et al.[14] indicated many parameters stated in the Minister of Health Regulation were deviated. These include pH (10%), hardness (34.4%), sulphate (0,8%), sulphide (14.8%), ammonia (71.1%), nitrate (8.6%), BOD (47%), detergent (6.3%), oil and grease (100%), phenol (75%), chloride (2.3%), iron (48%), manganese (3.9%), zinc (1.6%), and mercury (3.1%). The coliform bacteria of sampled waters ranged between 1069—1800/100 cc, while the MPN (Most Probable Number) ranged between 200—6,400.000/100 cc in the dry season and 240—6,950.000/100 cc in the rainy season.

Bacteriological pollution

Beside the aforementioned studies, there are many more studies dealing with bacteriological pollution of water.

Studies on bacteriological pollution of ground waters mostly deal with the contamination of wells by night soil. Bachmid Johan Muller[15] studied the presence of *E. Coli* in hand pump wells located near latrines. His study in Ujung Pandang, South Sulawesi, revealed that all hand pump wells located within the radius of less than 8.80 meters from the latrines are contaminated by *E. coli*. Soemini A.R.[16] who studied dug well in Cilandak, Jakarta, found that the safe distance between the wells and the latrines is 6.70 meters, while Sudung Sahat H. Nainggolan in Lenteng Agung, Jakarta, found that the safe distance is 6.88824 meters.[17] The difference in the results is understandable since there is a difference in the nature of the soil, the depth of the wells below surface, and possibly the amount of bacteria between Ujung Pandang and Jakarta. Bacterial activity decreases with depth. At 1.3 to 2 m there is little or none and at 3.3 to 4 m it is completely sterite.[18] The more poreous soil needs more distance between the wells and the latrines. Study done by Slamet Purwanto in Banyumas, for example, shows that the safe distance between the wells and the latrines will be from 15.5 m, and onwards.[19].

However, the above figures do not mean that the well waters condition in Jakarta and other big cities is bacteriologically safer. Jakarta and other big cities are more crowded. Although the required safe distance is only 7 meters around the latrine, to dig a well beyond this distance is usually impossible. Therefore it is not suprising to know that the quality of shallow wells water in Jakarta and around the vicinity investigated had been found to be contaminated bacteriologically.[20] The coliform bacteria content ranged between 30–240,000 MPN/100 cc.

Not only the distance between the well and the latrine contributes to the

becteriological pollution of ground water resources, but some wells which are located within the safe distance from latrines were also shown to have high number of coliform bacteria.[16] According to the study it is due to the behavior of the people. This conclusion is supported by a study done by Hilwati[20] on factors aftecting the bacteriological quality of hydrant waters in Grogol Petamburan of Jakarta. Yet, it is rather difficult to make a clear description on the becteriological quality of the ground waters, since there are only a few studies observing the severity of the contamination and the magnitude of the problems.

There are also very limited number of studies observing the bacteriological pollution of rivers. Pusat Penelitian dan Pengembangan Perkotaan dan Lingkungan DKI Jakarta (the Jakarta Center for Urban and Environment Research and Development) who studied river water in 50 locations throughout Jakarta in 1981 concluded that almost all of the rivers are highly polluted by biological pollutants, especially during the dry seasons.[22] The University of Indonesia in its 1983 study on water pollution of Sunter River and Cakung River, both are in Jakarta, showed that most people living along the rivers used the rivers for defecation.[23] Tjokroamidjojo et al. studied the river of Tegalweru village in Malang (East Java)[24] found that the water contains many parasitic bacteria. Sonny Priajaya Warouw who studied the Cisadane River found that there were in average 34,940 colonies of bateria per-cc of water.[25] As, most rivers flow to the sea the bacteriological quality of the sea waters in surounding coastal regions is also of concern.

There are six studies described the state of bacteriological pollution of the sea waters. Josephine T. D. Listiawati and Soeminarti S. Thayib studied Teluk Jakarta waters and the vicinity.[26] The observations done from September 1974 to February 1975 and from July 1976 to June 1977, showed the distributions of the MPN of the coliform bacteria are succesively 460—240,000/100 cc and 0.15×10^3 100 cc. The study also revealed that, in general, the MPN of the coliform increased every year during the period of the study.

The study done by LON (National Institute of Oceanology) in 1982 in Selat Sunda waters showed the area was still safe (according to the standards). However, there has been a tendency of significant increase of coliform pollutants.[27] In the first observation (June 1982), the MPN was 0—180/100 cc with the average of 43/100 cc. Meanwhile, in the second observation (October 1982) the MPN increased to 30—610/100 cc with the average of 255/100 cc.

In 1982, Soeminarti S. Thayib studied the bacteriologic pollutants, expecially the pathogenic bacteria, in Teluk Jakarta waters.[28] The result showed the sea waters was relatively free from *E. Coli.* However, although the MPN of *E. coli.* was only 54/100 cc, the water contained vibrio of *Proteus* and *Citrobacter* species which are pathogenic. The 1982 LON study of Laut Sulawesi found *Vibrio parahemolyticus and Salmonella* in some observation stations.[29]

In 1985 study by Soeminarti S. Thayib et al. in the northern coast of Bali[35] showed the MPN of bacteria was increasing and some pathogenic bacteria were isolated. A similar

study by the same researchers done in Teluk Cilacap, Central Java, showed the following results: [31] Some species of pathogenic bacteria isolated from June 1984 to March 1985 include *Proteus*, *Citrobacter*, *Edwardsiella*, *Pseudomonas*, *Salmonella*, Fecal coliform and *Providencia*. They suggest that the sea waters are equally as contaminated as other water sources.

Physcial and chemical pollution.

The increasing industrial areas in Indonesia increases the possibility of physical and chemical pollution to water bodies. The problem arises due to not only the quantity and diversity of wastes to be discharged, but more important are the attitude and behavior of the industries managements in disposing their industrial wastes. Badruddin Mahbub, Suyatna Anggadinata and Ibrahim Sumanta in their study found that there were at least 32 factories disposing wastes into only one river, i.e. Cibodas River. Most of them (92.8%) disposed the wastes directly without any treatment.[32] Sri Soewasti Soesanto et al. and Proyek Penelitian Pencemaran Industri (Indstrial Pollution Research Project) in their studies in Jakarta found some factories have no waste treatment plant and even the large factories which own waste treatment plants have not been able to treat their wastes properly.[33,34]

In Jakarta, in 1978 a study had been done to observe the Cakung River in accordance with the pollution from factories and household refuse disposal. The study revealed that the industrial wastes and household refuse disposed into Cakung River play an important role in the degradation of water quality of the river. [35]

S. Surtipanti et al. [36] who studied water pollution of the industrial areas of Jakarta—Bogor—Tangerang—Bekasi (Jabotabek) in 1983 found metal industries release heavy metals pollutants into waters.

Heavy metals became more important as water pollutants in Indonesia since 1980s. One of the methods of identifying heavy metals pollution is through their deposits in fishes or other aquatic organisms. L. Thamzil, S. Suwirma, and S. Surtipanti in their study of heavy metal pollution in Sunter River[37] obtained the following results: Hg 1.2—20.6 ppb, Cd 0.03—0.24 ppm, Zn 0.10—0.31 ppm, Pb 0.06—0.30 ppm, Ni 0.05—0.25 ppm, Co. 0.05—0.20 ppm, and Fe 0.27—0.76 ppm, while the physical parameters were pH 6.4—7.6, temperature 27.6—31.1°C, turbidity 126—328 ppm and dissolved oxygen 2.8—7.3 ppm. The data shows that the heavy metals, especially mercury and lead were in high concentration. Pusat Penelitian dan Pengembangan Perkotaan dan Lingkungan DKI Jakarta (the Jakarta Center for Urban and Environment Research and Development) studied rivers water in 50 locations of Jakarta also concluded that in general the rivers had been highly polluted by lead.[22]

Muhammad Taufiq studied Ciliwung River in 1983.[38] He compared the water quality of the river before and after entering Jakarta. He found the quality of the water was good in the last check point before entering Jakarta city borderline. After flowing through the city, the water became polluted. In the check point near the branching of the river into the Banjir Kanal, the water quality was moderate. The quality became worse as the river is approaching its

estuary.

In 1981 Soetjipto studied the pollution of cadmium in some water basins in Wonokromo (East Java). Analyzing the deposit of cadmium in the lobsters cultured in the basins, he concluded that the basins had been polluted. The concentrations of cadmium in the three basins were sucessively 0.0239 ± 0.0069 ppm, 0.0258 ± 0 0054 ppm, and 0.0235 ± 0.0071 ppm.[39]

Fuad Amsyari et al. also in East Java i.e. in Surabaya River, studied the pollution of mercury, cuprum, and cadmium.[40] The results of the study showed that the average concentration of mercury, cuprum, and cadmium in bader fish *(Buntius javanicus)* and keting fish *(Arius caelatus)* were 0.74 ppm, 0.32 ppm, and 0.05 ppm respectively. The concentration of these heavy metals in bader fish did not differ significantly from that in keting fish, and both appeared to be a little higher than the FAO recommended limit for Hg and Cu concentrations in fishes for human consumption.

Soelastri Darwati S. et al. who studied the condition of Surabaya River earlier (1982) confirmed that the river is highly contaminated and thus it is not suitable to be a source of raw water for drinking water treatment plant. The BOD (Biological Oxygen Demand) of the river is more than 6 ppm on the average.[41]

Agustina Lubis who studied the concentration of mercury in mujair fishes *(Tilapia mossambica)* cultured in three water basins in Jakarta concluded that the three water basins observed were polluted. The concentration of mercury were 0.22 ppm, 0.15 ppm, and 0.24 ppm respectively.[42]

Mercury deposit caused by pollution was also studied by Fuad Amsyari et al. in Surabaya. Instead of analyzing mercury deposit in fishes, they studied the mercury concentration in the hair of people consuming fishes using Activated Neutron Analysis[43]. The same method was also done by Tri Tugaswati et al. in Jakarta.[44] Both these studies revealed that the water pollution of mercury was yet to be a danger to human health. The mercury concentration in the hair indentified by Fuad Amsyari et al. was 10.71 ppm, while Tri Tugaswati et al. found it ranged between 1.84 — 33.71 ppm among male and 1.17—31.84 ppm among female. Tri Tugaswati et al. also studied the concentration of mercury in water consumed by the people and found it was still in safe level. i.e. 0.001 ppm. In 1984 a study done by Proyek Penelitian Pencemaran Industri (Industrial Pollution Research Project) in Jakarta confirmed the findings by the two previous researchers, although it suggested that other metals, i.e. Pb, Fe, Zn, Mn, and Cr had been discharged into rivers in excessive amounts as to endanger the river water.[34]

Although the concentration of mercury may be still of the level unhazardous to health, but other heavy metals, i.e. nickel and chromium had been found to cause dermatitis. In Gersik, East Java, Suwito[45] studied the effect of Lake Kajen pollution by factories manufacturing gold plated accesories in relation to the health of the community that used the lake water for bathing and laundering. The studied population showed 25.7% suffered from skin infections 13,3% diagnosed as dermatitis, and 7.5% was positive by patch test against nickel and chromium.

Proyek Pengelolaan Sumber-sumber Alam dan Lingkungan Hidup (Natural Resources and Environment Management Project)[46] who studied rivers and wells in Yogyakarta also found that the DO (Dissolved Oxygen) of the water bodies are generally low. Industrial pollution of water has, in fact, occured in Yogyakarta with the highest level of pollution in the downstream of the rivers. Chemical pollutants identified include ammonium, nitrate, phosphate, and chromium. Study by Totok Gunawan[47] in Mergangsan, Yogyakarta to analyze water pollution by batik printing factories, revealed that there has been a severe pollution caused by industrial wastes disposed into the rivers (surface waters) as well as into the wells (ground waters).

Beside batik printing factories described above,[47] some other factories had also been studied for their potential polluting effect. Nurinas found that in Majalaya, Bandung and Banjaran (West Java), pollution from textile factories had been spreading out.[48] Another study done by the Direktorat Jenderal Industri Kecil (Directorate General of Small Industries) in Central Java also revealed that batik printing industries play a significant part in water pollution.[49]

The pollution of paper factory into Bekasi River in West Java, was studied by Karno.[50] The study concluded that due to the pollution of the paper factory, the COD, temperature, suspended solids, hardness, pH and the SO_4 concentration of the river exceeded the permissible level stated in the Ministry of Health Regulation.[13]

Subarijanti and Herawati Umi studied the water pollution by sealing wax factory in Umbul River, Probolinggo(East Java).[51] This study showed the low diversity of the plankton (under 0.7), which suggests the river had been higly polluted.

The food additive (monosodium glutamate) factory in Mojokerto when it was studied by Utomo Hari[8] was harmless to the nearby river. But another similar factory in Probolinggo (East Java) which was studied by Sutini and Lidwina[52] showed potential pollution. In Gending River and Pesisir River, at the segment where the factory is located, there was a significant increase of CO_2, NH_4, Nitrate, and organic matters concentration and the BOD. The temperature and the acidity of the water were low, but the electric conductivity of the water was high. In most ponds watered by the river, there was a significant decrease of the number of plankton, especially in the area downstream the factory.

Observation into the water pollution caused by sugar and spirits factories done by Hermani S. Djalal Tanjung[53] revealed the potential of the factories, especially in increasing the temperature of the river water which decreased the dissolved oxygen.

Musi River in South Sumatera had also been studied for its water pollution. The study done by Saeni M.S., RTM Sutamihardja, and R.C. Tarmingkeng[54] revealed no water quality degradation in the river segment between Boom Baru and Pulau Kembara. Similar condition was also found in the upstream segment of the river (near Pulau Borang). But approaching the downstream segment, the water quality of the river degraded severely. Ammonium nitrate and the COD (Chemical Oxygen Demand) exceed the permissible level due to the pollution from fertilizer and rubber factories. Even in the industrial area segment the concentration of the ammonia and suspended

solids were very high. Nearly all parts of the river crossing Palembang city had BODs exceeding the permissible level for raw water for drinking water consumption. So as the level of acidity.

Water pollution caused by tapioca industrial waste forms the most serious environmental problem in Lampung. A study done by Badruddin Mahbub, Rachmadi H.S., and Ibrahim S. revealed that the waste discharged by a tapioca industry with the production capacity of 300 tons a day contains 10,500 mg/l BOD; 20,550 mg/l COD and 16.8 mg/l Cn.[55]

Most rivers flow to the sea. Thus the physical and chemical pollution of rivers will directly affect the physical and chemical condition of the sea waters. Wahyu Santoso et al. who studied the physical and chemical quality of Teluk Jakarta water, found that the industrial wastes is a dominant pollutant of the waters.[56] Sofyan Yatim et al. who studied the same area of waters concluded that the concentration of Hg, Pb, Ni, and Zn in the water exceeded the critical level.[57] It was also noticed that the chemicals have been spread out and even acummulated in some parts of the waters. In addition, Muswery Muchtar found a high concentration of silicon-silicate in the same waters.[58]

Horas P.H. and R. Hamidah studied the wider areas of sea waters in 1982, including Muara Angke Estuary, Teluk Banten, Northern Coast of Java, Selat Makasar and Laut Sulawesi.[59] They found that the concentration of mercury in those sea waters were 10—27 ppb for Muara Angke, 3—4 ppb for Teluk Banten, 6.1 ppb for Northern Coast of Java, 1.8—4.8 ppb for Selat Makasar, and 1—13 ppb for Laut Sulawesi. Since the normal concentration of mercury in sea water is 0.15 ppb., it is clear that those sea waters had been heavily polluted by mercury.

The industrial wastes seem to be not only polluting surface waters, but ground water as well.

Endang Mastuti W (1984)[60] who studied water pollution problems in Surakarta, Central Java, found the presence of industrial waste pollutans in the private dug wells of the community, especially in Subdistrict Pasar Kliwon. Inswiasri et al. in their study done in Jakarta on heavy metals concentration in water found that in almost half of the studied wells, although the concentration of Cu and Zn were still below the permitted maximum, the concentration of Hg (mercury) was in excessive.[61] Badruddin Mahbub et al. even detected a high concentration of nitrate in the wells water they studied in Jakarta, although this concentration ($NO_3 > 10$ mg/cc) is still below the permitted maximum.[20]

Iskandar Sumana studied the effect of waste disposal from 94 tofu (soya cakes) factories in Jakarta upon the private wells of the community.[62] The results showed the organic matters concentration of 6.636—22.436 mg/l, the nitrate concentration of 0.04—0.3 ppm, and the ammonia concentration of 0.15—0.6 ppm. The average values of these concentrations are 14.04 ppm (organic matters), 0.1103 ppm (nitrate), and 0.39 ppm (ammonia), thus concluded that those tofu factories are potential sources of pollution for the community private wells.

Other sources of physical and chemical pollution.

Water pollution caused by detergent can be classified into industrial pollution. But in fact, the pollution mainly come from the community activities using the detergent, especially for laundering purposes. Therefore it seems to be more convenient to classify the pollution into household wastes pollution.

However, the detergent pollution seems to be still in an uncritical state, such as only a few studies were carried out. A study done by Asep Ali Kudus in Lake Panjalu, Ciamis (West Java) revealed that the detergent pollution to the lake water is still relatively low.[63] Yet, in some big cities it is not impossible that the detergent problem is getting more serious. Badruddin Mahbub et al. for example, found a high concentration of detergent in shallow wells in Jakarta and the vicinity.[20]

Another source of water pollution which is still neglected is solid waste. However, Kumoro Palupi et al. in their 1982 study indicated that in four cities of Java solid waste was the major pollutant of the river (87.5%).[64]

The use of fertilizer and pesticide attracted some researchers from the University of Andalas. In 1980 Abubakar et al.[65] studied the side effect of fertilizer and pesticide used for agricultural purposes. Even though they failed to detect pollution of pesticide, the study revealed that the use of fertilizer had increased the concentration of N, P, and K in the water of the private community dug wells.

With the decrease of ground water reserve of the earth, a new problem of pollution emerges, i.e. sea water intrusion. More researchers seem to be attracted by this increasing problem. Studies by Bambang Soejadi and Sukibat R.S.,[66] by Pusat Litbang Pengairan (Center for Water System Research and Development),[67] and by Soenarto B and Widjaja J.M.[68] showed that there have been extensive intrusion of sea waters into ground water table, especially through river. Badruddin Mahbub et al.[20] concluded that most shallow wells in Jakarta and the vicinity located 7.5 km from seashores have salinity above the permitted maximum concentration. Joyce Martha Widjaja even stated that the intrusions of sea water in Jakarta have reached the distance of ±13 km away from the seashores. Not only salt being transported by the water, but also some minerals. Hisyam S.W.[70] found that the intrusion of Premulung River water into the community private wells located 3—15 meters away from the river transporting not only salt but also manganese..

CONCLUSION

From the above description, it is obvious that :

1. Water pollution has become a serious problem in Indonesia especially since 1980s.
2. Almost all sources of water, i.e. rivers, lakes, basins, oceans, as well as ground waters which were studied have been polluted.
3. The water pollutants consist of all kinds including bacteriological, physical as well as chemical pollutants.
4. The bacteriological pollutants are mostly originated from the night soil contamination due to the close distance between the water bodies and

the latrines and the improper behavior of people in handling the water supplies. However, there are only a few studies dealing with the magnitude of the bacteriological pollution of rivers and ground waters.

5. The physical and chemical pollutants are mainly heavy metals originated from the industrial wastes. Although the concentration of some pollutants are still within the permitted limits, some others are beyond the limits.
6. The problem of industrial wastes pollution into waters is mainly caused by the ignorance in the industrial waste management. Most of the industries still dispose their wastes directly into rivers or other water bodies without any treatment.
7. Other pollution sources which are potential but still being given less attention by researchers include the household use of detergent, garbage disposal, and the use of pesticides and fertilizers. The "new' kind of pollution which is more attractive to the researchers seems to be sea water intrusion. Some studies done in this matter indicate the problem is really getting serious, especially within a certain distance of the seashores.

RECOMMENDATIONS

1. More studies are needed to analyze further the water pollution problems in Indonesia, especially in relation with night soil contamination of surface and ground waters, the pollution of water bodies by other pollutants such as solid wastes, detergent, fertilizer and pesticides, and the sea water intrusion.
2. Looking at the serious problem of the water pollution, it is suggested to increase the health education activities for the communities regarding the preservation of water resources, including the efficiency in using water, and the proper water supply handling.
3. Beside health education activities, the application of law and regulations concerning water pollution should be reinforced and supervised effectively. More attention should be given to the industries regarding their practices in industrial waste treatment.

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(Most of the above references are unpublished documents, except those with the*).