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필리핀의 수질현황 및 미래 관리계획

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Status of Water Quality and Future Plans in the Philippines

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요약 : 필리핀은 많은 섬들로 이루어진 국가로 물 뿐만 아니라 각종 자연환경이 풍부한 국가이나, 금세기 들어 필리핀의 농업활동 및 빠른 도시화로 인한 도시 및 산업지역으로부터 야기되는 수질오염이 심각해지고 있다. 필리핀 국가 환경관리국은 수질 모니터링과 수계오염원인 조사 등을 책임지고 있는 최고의 국가기관으로 수질오염원 원인분석과 해결방안을 모색하기 위하여 다양한 노력을 하고 있다. 그러나 DO, BOD, TSS, TDS, 중금속, coliform 등에 대해 년간 4회 이상의 모니터링 수행과정을 통해 수질관리를 하고 있기에 수질개선에 애로사항이 많다. 현재 필리핀의 각종 수질은 도시하수, 산업폐수, 농업폐수 및 비점오염원에 의해 영향을 많이 받고 있는 것으로 나타났으며, 도시 하수관거의 불량도 수질에 크게 영향을 끼치는 것으로 나타났다. 본 연구의 목적은 필리핀의 수질오염원인 및 정도를 분석하고 그 결과를 제시함으로써 향후 국가적으로 관심을 가져야 할 분야가 어디인지를 명시하기 위하여 수행되었다.

핵심용어 : 지하수, 해양수, 비점오염원, 필리핀, 점오염원, 수질

Abstract : The Philippines is abundant with rich natural resources such as water. Because of rapid urbanization in the country, most of the water bodies are polluted as a result of domestic, agricultural and industrial activities. The Environmental Management Bureau (EMB) is the main government arm responsible for monitoring and inspection of affected water bodies. Only water bodies with at least four sampling events during dry and wet seasons were included in the assessment of water bodies that passed the DAO 90-34 water quality criteria. Water bodies were monitored for dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solids (TSS), and total dissolved solids (TDS), heavy metals, fecal coliform contamination and nitrates. High pollutant concentrations from domestic, agricultural, industrial and nonpoint sources were observed from monitoring events due to inadequate sewage services and treatment facilities in the country. The objective of this paper was to present and evaluate the quality of the water bodies in the Philippines.

Keywords : Groundwater, Marine, Nonpoint source, Philippines, Point source, Water

1. Introduction

The Philippine archipelago is composed of 7,107 islands stretching to an area of 300,000 km2. With 2.2 million km2 of contiguous territorial waters and exclusive economic zone corresponding to almost 90% of the total area, the Philippines is significant maritime state in Southeast Asia (ADB, 2004). The country is divided into three geographical areas: Luzon, Visayas, and Mindanao. It is has 17 regions namely

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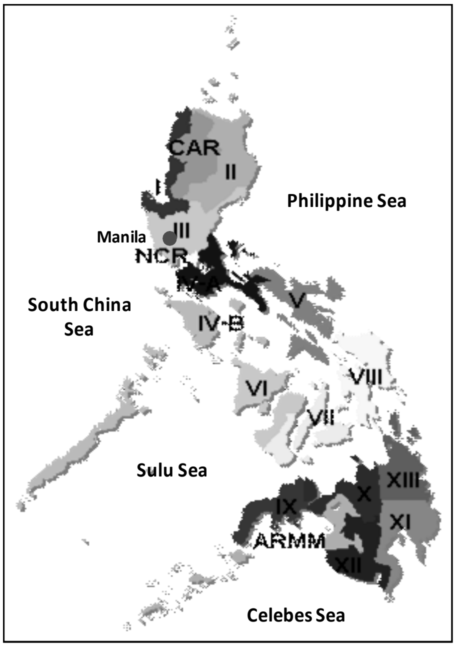
Regions I to XIII, the National Capital Region (NCR) or Metropolitan Manila, Cordillera Administrative Region (CAR), and the Autonomous Region in Muslim Mindanao (ARMM), respectively (Fig. 1). Manila is the national capital of the Philippines.

As of 2007, the country has an estimated population of 88.6 million people with an annual growth rate of 2.04% making it the 12th most populous country in the world. The projected population for 2025 is 107 million, implying an annual over all growth rate between 2004 and 2025 of 1.7% (NSO,2009). With 64.2% of its total population living in urban centers, Philippinesis 4th of the most urbanized country in Southeast Asia and the 8th most urbanized country in all of Asia. The size of the rural population is remaining more or less constant, while the urban population of the Philippines is now growing by 3.2% every year (UNESCAP, 2008). The agricultural sector which accounts for about 30% of the gross domestic production (GDP) is the country's economic backbone. Most of regions in the country relay on the agricultural and agro-industrial sector for aliving. The 2nd largest contributor is the in dustrial sector. There are about 15,000 establishments in the country and 69% of which are located in Metro Manila, Region III, and Region IVA-CALABARZON (EMB, 2006).

Two distinct seasons, the wet season from July to December and the dry season from January to June characterize the tropical climate of the Philippines. These seasons bring about temperatures ranging from a cool of 18.7oC in January to a peak heat of 36.0oC in March (NSO, 2009). The Philippines has high relative humidity due to



List of Regions	
ARMM	Autonomous Region in Muslim Mindanao
CAR	Cordillera Administrative Region
NCR	National Capital Region
Region I	Ilocos Region
Region II	Cagayan Valley
Region III	Central Luzon
Region IV-A	CALABARZON
Region IV-B	MIMAROPA
Region V	Bicol Region
Region VI	Western Visayas
Region VII	Central Visayas
Region VIII	Eastern Visayas
Region IX	Zamboanga Peninsula
Region X	Northern Mindanao
Region XI	Davao Region
Region XII	SOCSARGEN
Region XIII	Caraga Region

Fig. 1. Political map of the Philippines

its high temperature and the surrounding bodies of water. The average monthly relative humidity varies between 71% in March and 85% in September. The annual average rainfall in city areas is 2030 mm and ranges from 1,000 mm in some of the sheltered valleys to as much as 5,000 in the mountainous coast section of the country. The Philippines suffers through dangerous storms from July to October. Annually, an average of about 20 storms hit the country. Frequently affected are the northeastern parts of Luzon, Regions V and VIII. Manila gets devastated periodically with rainstorms as well.

The Department of Environment and Natural Resources (DENR) is the executive department of the Philippine government responsible for governing and supervising the country's natural resources. Under DENR, the Environmental Management Bureau (EMB) enforces water quality criteria and standards, and effluent regulations in all of water bodies in the country. Presidential Decree (PD) 1067 or the National Water Code in 1976 provides the basic principles and structural framework for the appropriation, control, conservation, and protection of water resources. Other water management laws are Republic Act (RA) 8041 or National Water Crisis Act of 1995, Environmental Impact Assessment System (PD 1586) and the Local Government Code (RA 7160). The 1977 Philippine Environmental Code (PD 1151) defines the framework for water quality control, consisting of discharge standards, permits, monitoring, and enforcements. In 2004, Philippine Clean Water Act (RA 9275) is promulgated to provide a regulation for abatement of water pollution from point and NPS and enforcement for fees and penalties regarding wastewater charge system. Other policies pertaining to water quality control include DENR Administrative Order (DAO) 90-34 or the Revised Water Usage and Classification/Water Quality Criteria, Revised Effluent Regulations of 1990 (DAO 90-35)and Philippine National Standards for Drinking Water (DAO 94-24A).

Rapid urbanization in the Philippines contributed largely to the deterioration of its water bodies. Only 36% of the river sampling points has been classified as suitable source for public water supply and 58% of groundwater intended for drinking are contaminated with total coliform and therefore requires treatment. According to the Department of Health (DOH), approximately 31% of illness for a five-year period was from water-related diseases (WB, 2003). EMB monitoring results revealed that domestic wastes are the major source of pollution (33%), followed by livestock (29%) and industrial sources (27%). Non-point sources (NPSs) of pollution account for 11% of the organic load contribution to water bodies (EMB, 2006).

This paper provides a general overview of the current situation of water quality in the Philippines. The objectives of this paper were to discuss the main pollutants affecting the water bodies of the country, provide a summary of water bodies affected by these pollutants and to discuss the current methods used by the country to treat affected water bodies. A comparison with the above results with other developed countries was made at the end of this paper.

2. Water resources

The Philippines is endowed with rich natural resources such as water. Water resources in the country include rivers, lakes, groundwater, and coastal and marine waters. Rivers and lakes occupy 0.6% of the total area. The country has 18 major river basins (Table 1) and 421 principal rivers in 119 proclaimed watersheds as defined by the National Water Resources Board (NWRB). The largest river, the Cagayan River Basin, has a drainage area of 25,649 m2. As reported by the Bureau of Fisheries and Aquatic Resources (BFAR), there are 79 lakes in the country. Most of these lakes are used as host for aquaculture production.

Table 2 shows the ten major lakes in the Philippines. Laguna Lake is considered as the largest lake with a total area of 3,813.2 km2 (watershed area and lake proper). Sixty-four of the 79 provinces in the country are in coastal areas. Coastal and marine waters cover an area of about 266,000 km2, including bays and gulfs. The country's coastline stretches to about 17,460 km and coral reefs cover an area of about 27,000 km2 (EMB,2006). The country has a vast groundwater reservoir with an area of about 50,000 km2. Groundwater is recharged by rain and seepage from rivers. The recharge or extraction potential is estimated at 20,200MCM per year. Groundwater contributes 14% of the total water resource potential of the Philippines and 50% of the population uses groundwater for drinking (WB, 2003).

3. Sources of water pollution

Sources of water pollution can be classified as point source (PS) and NPS. PS are

Table 1. Major river basins in the Philippines

River Basin	Region	Drainage Area (km^2)
Cagayan River	Cagayan Valley	25,649
Mindanao River	Southern Mindanao	23,169
Agusan River	Northern Mindanao	10,921
Pampanga River	Central Luzon	9,759
Agno River	Central Luzon	5,952
Abra River	Ilocos Region	5,125
Pasig-Laguna River	Southern Luzon	4,678
Bicol River	Bicol Region	3,771
Abulug River	Cagayan Valley	3,372
Tagum-Libuganon River	Southeastern Mindanao	3,062
Ilog-Hilabangan	Western Visayas	1,945
Panay River	Western Visayas	1,843
Tagoloan River	Northern Mindanao	1,704
Agus River	Southern Mindanao	1,645
Davao River	Southeastern Mindanao	1,623
Cagayan River	Northern Mindanao	1,521
Jalaud River	Western Visayas	1,503
Bauyan-Malungun River	Southeastern Mindanao	1,434

characterize the quality of water bodies in the Philippines. Among the parameters discharged pollutants coming from a single identifiable source and NPS are discharged pollutants coming from diffuse sources. DAO 90-34 classified 33 parameters that monitored are dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), heavy metals such as mercury, lead, chromium and cadmium; fecal coliform and nitrates.

In 2005, the estimated annual pollution from PS is about 3.8 million metric tons of BOD (EMB, 2006). Domestic wastewater discharges is the main contributor in terms of BOD loading, representing 33% of the total load (Fig. 2). Domestic sources contribute highest to the BOD load as the lack of sewage treatment system allows more than 90% of inadequately treated domestic sewage to be discharged into surface waters. One-third of the country's domestic BOD wastes come from Metro Manila and Region IV at 18 and 15%, respectively (WB, 2003).

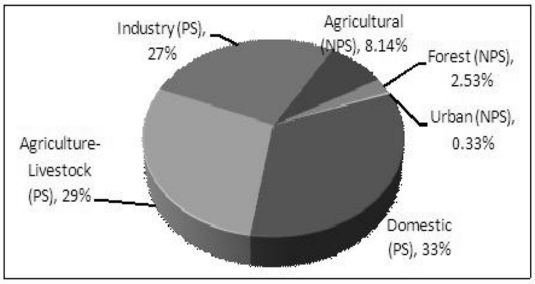


Fig. 2. Distribution of water pollution sources (Source: EMB, 2006)

Table 2. Number of classified water bodies (Source: EMB, 2006)

Classification		Number
Fresh Surface Waters		
Class AA:	Waters which are uninhabited and approved to meet the National Standards of Drinking Water (NSDW) of the Philippines	5
Class A:	Water supply that will require complete treatment to meet NSDW	203
Class B:	Waters for primary contact recreation (e.g. bathing, swimming, skin diving, etc.)	149
Class C:	Waters for fishing, recreation/boating and supply for manufacturing processes after treatment	231
Class D:	Waters for agriculture, irrigation, livestock watering, industrial cooling, etc.	23
Coastal and Marine Waters		
Class SA:	Water suitable for fishery production, tourism, marine parks, coral reef parks and reserves	4
Class SB:	Waters for recreation such as bathing, skin diving, etc., and as spawning areas for Bangus and similar species	20
Class SC:	Waters for recreation/boating, fishery, and as mangrove areas for fish and wildlife sanctuaries	27
Class SD:	Waters used for industrial purposes such as cooling	3

The second largest contributors to pollutant loading are the agriculture and livestock from PS (29%). Agriculture and livestock activities generate high organic wastewater and the absence of facilities to treat these runoffs degrades the water quality of surface and groundwater. Regions I and IV generate the highest load of agricultural BOD accounting for 12 and 13% of the total load generation, respectively (WB, 2003). Twenty-seven percent of the total BOD generation comes from industrial wastes. Approximately 2,000 m3 of solvent wastes, 22,000 tons of heavy metals, infectious wastes, biological sludge, lubricants, and intractable wastes, as well as 25 million m3 of acid/alkaline liquid wastes are improperly disposed of annually in the Metro Manila area alone. A study by the Japan International Cooperation Agency (JICA) conducted in 2001 states that around 700 industrial establishments in the Philippines generate hazardous wastes of about 273,000 tons/yr. There is no integrated treatment facility for hazardous wastes in the country although there are about 95 small to medium-scale treatment facilities that treat hazardous wastes (i.e., used oil, sludge). There are approximately 50,000 tons of hazardous wastes stored on or offsite due to lack of proper treatment, recovery and recycling facilities (Greenpeace, 2007). NPS represents 11% of the total generation of BOD composed of agricultural runoff (8.14%), forest runoff (2.53%) and urban runoff (0.33%).Using the current land use, the estimated annual pollution from NPSs is 435,000 metric tons of BOD excluding runoffs from landfills and dumpsites (EMB, 2006).

4. Water quality

4.1 Classification and criteria

According to the DAO 90-34, the quality of Philippine waters shall be maintained in a safe and satisfactory condition according to their best usages. Table 2 presents the breakdown of the number of classified water bodies in the country. As of 2005, EMB has classified 525 water bodies in terms of best usage and water quality, representing 62.5% of the inventoried water bodies in the country (EMB, 2006). Majority of the fresh surface waters in the Philippines are Class C waters which are mainly used in recreation and manufacturing processes. Only 5 rivers coming from Regions VII, XI and CAR are classified as a good source of drinking water. The water quality criteria serves as a standard needed to maintain the minimum conditions necessary to assure the suitability of water for its designated use or classification. Table 3 presents the water quality criteria for conventional and other pollutants affecting aesthetics and exerting oxygen demand for fresh waters while Table 4 shows water quality for coastal and marine waters.

4.2 Assessment

The quality of water bodies in the Philippines are assessed based on the number of samples that meet the requirements of DAO 90-34 water quality criteria. Only water bodies with at least four sampling events during dry and wet seasons were included. Table 5 shows the rating used by EMB to assess the water quality.

Parameters monitored for inland surface waters are DO, BOD, TSS, TDS, and heavy metals. Groundwaters were monitored for TDS, fecal coliform and nitrates while DO, coliform and heavy metals were monitored for coastal and marine waters.

Table 3. Water quality criteria for fresh waters (Source: DENR, 1990)

Parameter	Unit	Class				
		AA	A	B	C	D
Color	PCU	15	50	-	-	-
Temperature	oC rise	-	3	3	3	3
pH		6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.0-9.0
DO	% satn	70	70	70	60	40
	mg/L	5.0	5.0	5.0	5.0	3.0
BOD5	mg/L	1	5	5	7(10)	10(15)
TSS	mg/L	25	50	-	-	-
TDS	mg/L	500	1,000	-	-	1,000
Surfactants	mg/L	nil	0.2(0.5)	0.3(0.5)	0.5	-
Oil/Grease	mg/L	nil	1	1	2	5
NO3-N	mg/L	1.0	10	-	10	-
PO4-P	mg/L	nil	0.1	0.2	0.4	-
Phenolic Substances	mg/L	nil	0.002	0.005	0.02	-
Total Coliforms	MPN/100mL	50	1,000	1,000	5,000	-
Fecal Coliforms	MPN/100mL	20	100	200	-	-
Chloride	mg/L	250	250	-	350	-
Copper	mg/L	1.0	1.0	-	0.05	-

Table 4. Water quality criteria for coastal and marine waters (Source: DENR, 1990)

Parameter	Unit	Class			
		SA	SB	SC	SD
Color	PCU	-	-	-	-
Temperature	oC rise	3	3	3	3
pH		6.5-8.5	6.0-8.5	6.0-8.5	6.0-9.0
DO	% satn	70	70	70	50
	mg/L	5.0	5.0	5.0	2.0
BOD5	mg/L	3	5	7(10)	10(15)
TSS	mg/L	-	-	-	-
Surfactants	mg/L	0.2	0.3	0.5	-
Oil/Grease	mg/L	1	2	3	5
Phenolic Substances	mg/L	nil	0.01	(1)	-
Total Coliforms	MPN/100mL	70	1,000	5,000	-
Fecal Coliforms	MPN/100mL	nil	200	-	-
Copper	mg/L	-	0.02	0.05	-

Table 5. Water quality compliance rating (Source: EMB, 2006)

Rating	Percentage	Significance
Good	98-100	Water body complies with the desired water quality criteria and fully supports its intended beneficial use.
Fair	50-97	Water body partially complies with the designated water quality criteria and is not supporting its intended beneficial use in 50 to 97% of sampling instances.
Poor	0-49	Not able to support its intended beneficial use in 0 to 49% of sampling instances.

Table 6. Rating of water bodies per water quality parameter (Source: EMB, 2006)

Parameter	Rating (%)		
	Good	Fair	Poor
DO	47	40	13
BOD	47	41	12
TSS	23	69	8
TDS	55	42	3

4.2.1. Inland surface waters

From 2001 to 2005, the EMB monitored 196 inland surface waters, comprising 192 rivers and 4 lakes. Table 6 shows the rating of the monitored water bodies per water quality parameter. Less than half of the monitored water bodies are considered to have good water quality.

Shown in Table 7 are the DO and BOD levels of the priority rivers in the country from 2003 to 2008. Region V Rivers maintained an increasing level of DO while rivers from Region III exhibited a significant increase in DO levels but are still unable to meet the national criterion. NCR Rivers continue to exhibit deteriorating DO levels. Most of these rivers are located in highly urbanized areas where most of manufacturing establishments and households are situated resulting to a large discharge of domestic and industrial wastes. In the case of BOD, NCR and Ylang-ylang rivers exhibited the most significant increase. High BOD levels in these rivers are due to the discharge of domestic and industrial wastes from communities and industrial sites in the area (PRB, 2008).

Of the 46 water bodies monitored for TSS, only two water bodies in Region X failed to meet the standard TSS criterion due to the effects of sand and gravel quarrying activities and runoff from denuded forests and agricultural lands (PRB, 2008). In the case of TSS, only Marilao River has poor water quality, with an annual average TDS levels ranging from 1,785 to 3,265 mg/L. The primary sources of TDS in receiving waters are agricultural runoff, leaching of soil contamination, and industrial or domestic sewage (EMB, 2006).

Heavy metals are parameters not regularly monitored by EMB. Among inland surface waters, only Meycauayan, Bocaue and Marilao Rivers (Region III) are monitored for heavy metals. Annual average monitoring results of Meycauayan River in 2001, 2003, and 2004 show exceedances in chromium (2001), cadmium (2001), and lead (2004). Monitoring results of Bocaue River indicate that the River passed the criteria for chromium, copper, and cadmium. However, it showed high lead concentrations in all its sampling stations particularly during the dry season in 2004. Similarly, Marilao River showed exceedances in lead and cadmium in its Class A and C waters. Potential sources of heavy metals are tanneries, electroplating, and other similar industries located in nearby areas (EMB, 2006).

4.2.2. Groundwater

Protecting the groundwater quality is critical to ensure continuous supply of potable water. Assessment for groundwater quality is based on the standards set by the Philippine National Standards for Drinking Water (PNSDW). The standard for TDS level

Table 7. Annual average DO and BOD levels of the priority rivers (Source: EMB, 2009)

Region	Water Body	Class	DO (mg/L)			BOD (mg/L)		
			2003	2005	2008	2003	2005	2008
III	Meycauayan River	C	1.5	0.5	2.5	38	120	36
	Marilao River	A	0.8	1.1	2.4	32	42	11
	Bocaue River	C	1.9	2.7	5.0	12	6.4	12
IV-A	Imus River	C	3.0	5.2	4.1	5.6	10	11
	Ylang-ylang River	C	4.5	4.8	4.0	24	8.3	64
IV-B	Mogpog River	C	4.9	7.2	-	-	-	-
	Calapan River	C	3.1	2.9	3.1	4	16	3.8
V	Anayan River	D	5.6	5.7	6.5	9	2.3	2.8
	Malaguit River	C	4.6	5.8	7.4	5.7	0.7	-
	Panique River	C	2.7	5.6	6.9	4.4	2.6	-
VI	Iloilo River	-	4.2	4.9	4.5	2.4	3.4	4.4
VII	Luyang River	C	7.9	7.6	6.9	2.4	2.0	1.4
	Sapangdaku River	C	7.6	7.1	6.8	8	0.9	1.1
X	Cagayan de Oro River	A	8.6	8.1	8.1	1.2	1.3	-
CAR	Balili River	-	4.6	4.9	4.6	15	32	37
NCR	Marikina River	C	3.1	3.4	2.6	18	12	18
	San Juan River	C	2.4	2.7	1.9	55	34	44
	Parañaque River	C	2.5	1.3	1.6	42	30	38
	Pasig River	C	3.1	2.1	3.2	11	24	21

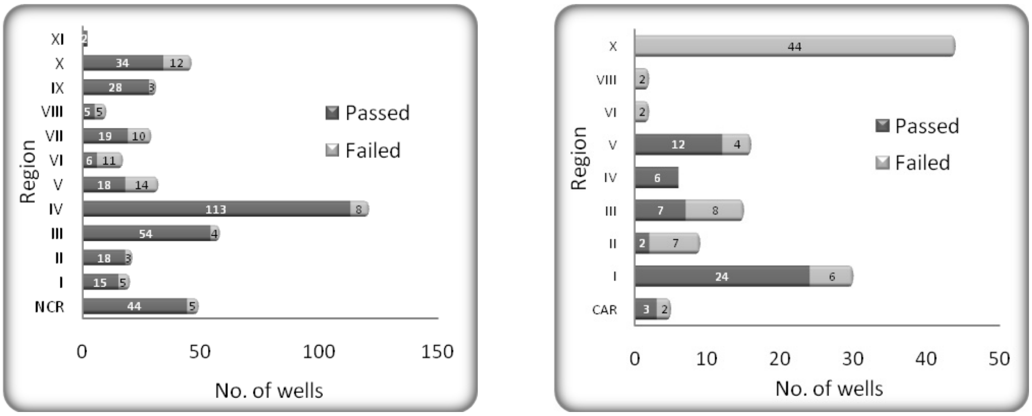


Fig. 3. Number of wells tested (a) for TDS and (b) for coliform (Source: EMB, 2006)

500 mg/L (DENR, 1990). Of the 436 wells tested for TDS, 80 wells failed to meet the prescribed criteria (Fig.3a). A total of 129 wells were tested for coliform contamination and 75 wells or 58% are not potable and failed to meet the fecal coliform standard (Fig. 3b). Possible sources of contamination are defective septic tanks without bottom lining, garbage dumps, animal wastes, and inadequately treated wastewater (EMB, 2006).

According to PNSDW, the maximum allowable nitrate level is 50mg/L (DENR, 1994). In 2004, the NWRB monitored 25 wells for nitrate level in groundwater. The well from San Vicente, Liloan (Region VII) exhibited the highest nitrate level of 80mg/l. Suspected sources of contamination are leaching from septic tanks, municipal garbage dumps and fertilizer runoff (EMB, 2006).

4.2.3. Coastal and marine waters

Fifty-four percent of the 26 coastal and marine water bodies monitored have good water quality while the remaining 46% show fair water quality. Average DO of all water bodies complied with the criterion of 5 mg/L except for the Cansaga Bay in Region VII which registered an average of 4.7 mg/L in 2002 (EMB, 2006).

As reported in the National Water Quality Status Report, 41 priority bathing beaches were monitored by EMB for Fecal Coliform in five consecutive sampling events in June 2005. Fig. 4 shows the water quality of the sampling stations per region tested for fecal coliform. 34 bathing beaches (83%) passed the criterion and only seven (17%) failed (EMB, 2006). Most of the failed stations are from Region III as a result of improper waste management practices by the communities and beach resort operators along the coastal area (EMB-R3, 2006).

Only 3 of the 77 coastal and marine waters in the country are regularly monitored by EMB for Mercury. Dupon Bay and Matlang Bay of Region VIII and Murcielagos Bay of Region IX have an annual average mercury concentration of 0.30, 0.34 and 0.73 mg/L, respectively. All annual average mercury concentrations exceeded with the criterion of 0.002 mg/L. As for lead monitoring, the three bays were monitored. Dupon Bay has an

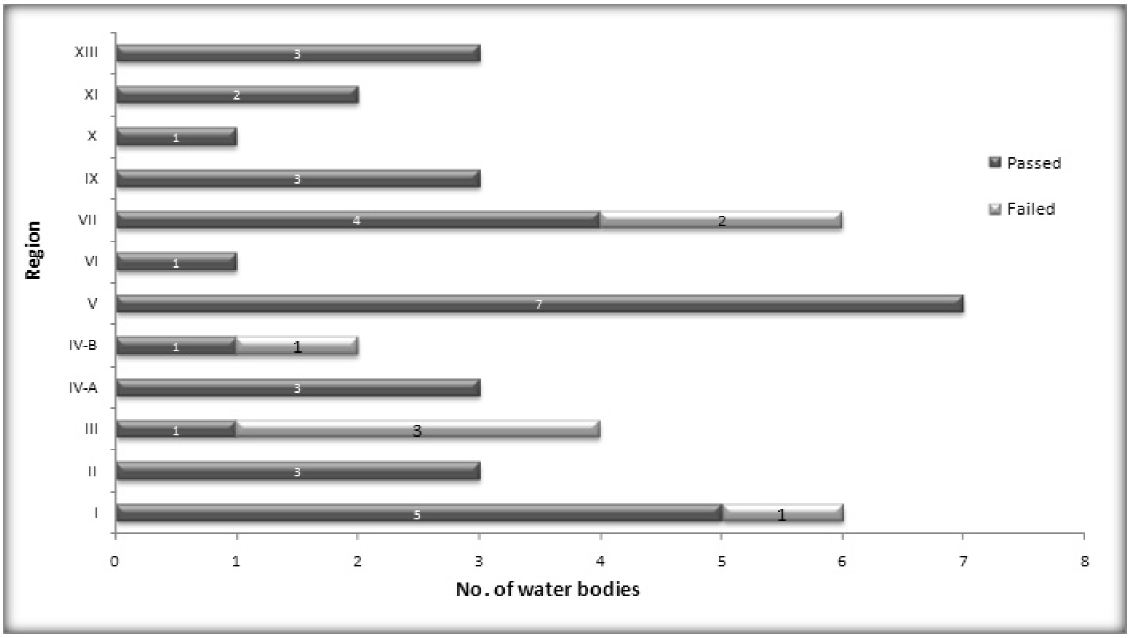


Fig. 4. Sampling stations per region tested for coliform water quality criteria (Source: EMB, 2006)

annual average lead concentration of 0.009 mg/L while Matlang Bays and Camotes Bay (Region VIII) have 0.005 and 0.011 mg/L, respectively. All three bays are within the set criterion for Class SB waters which is 0.05ppm (EMB, 2006).

5. Treatment and control measures

The Asian Development Bank (ADB) reported that approximately only 1% of the country's population has access to sewerage systems and 74% rely on on-site sanitation systems like sanitary toilets and septic tanks. Since 25% do not have access to sanitation services, untreated wastes are discharged directly into rivers and land (EMB, 2006). As a result, on-site solutions are common in the Philippines but due to poor operation and maintenance; it became the source of groundwater pollution. With little or no funds available, low-cost options are applied by the local government of some areas. Cities such as Manila, Iloilo and Bohol make use of Decentralized Wastewater Treatment Systems (DEWATS) to provide treatment for both, domestic and industrial sources. Even though DEWATS technology is low-cost, the pilot-scale system only treats one cubic meter of wastewater at a time and septic tanks require de-sludging every two or three years. In addition, a two-cell constructed wetland with a catchment area of 2680 m2was introduced in the Philippines to treat municipal sewage of more than 3000 inhabitants in the City of Bayawan, Negros Oriental located in Region VII. Also, Ecological Sanitation (EcoSan) became an alternative approach to treat sewage wastes by sanitizing urine and feces to be used as safe products for agricultural purposes.

Local Initiatives for Affordable Wastewater Treatment (LINAW) under the United States Agency for International Development (USAID) introduced a hybrid treatment technology in Muntinlupa (NCR) that treats wastewater by means of a combination of anaerobic and aerobic treatment coupled with filtration using cocopeat media to meet local discharge standards. It also includes a water recycling system that allows reuse of the treated effluent for flushing toilets, watering plants and street cleaning.

Public participation is also encouraged by the government. Under the Philippine Water Watch, local citizens play an important role in diagnosing water resource problems by helping in water monitoring and natural resource management planning. Also, an Environmental User Fee System (EUFS), adapted from the “polluters pay principle”, is implemented requiring commercial, industrial and agro-based industries to pay for the amount of discharge of wastewaters in Laguna Lake. Because the variable fee rate is concentration based, the EUFS has created a strong incentive to dilute discharges to reduce the BOD concentration.

6. Comparison to other countries

6.1. Point sources

Water pollution is a global concern. Pollutant loads are fast increasing that conventional treatment methods are not enough to meet the requirements of the present standard quality of potable water. To treat domestic and industrial wastewaters, advanced wastewater treatment methods are used especially by developed countries such as United States, Japan, Korea, Australia and also European countries. In USA, a Groundwater Replenishment System was introduced where treated sewer water undergoes an advanced treatment process that includes two membrane filtration systems - microfiltration and reverse osmosis, and treatment by ultraviolet light and hydrogen peroxide. In addition, overland treatment of wastewater is widely adopted in Australia, New Zealand and the UK for tertiary upgrading of secondary effluents.

In Japan, about 85 million Japanese residents are served by full-fledged sewerage systems, about 3 million have access only to "agricultural effluent treatment facilities," and about 380,000 have access to community wastewater treatment plants. An additional 10 million people use facilities called johkasoh onsite systems that treat domestic wastewater and discharge the treated effluent to a nearby waterway. In Europe, 90% of the EU-25 population is connected to sewerage networks. In the central Europe and the Nordic countries most wastewater now receives tertiary treatment, while in the southern countries; most waste-water receives secondary treatment primarily by the removal of organic matter.

For many developing countries, majority of domestic and industrial wastewater is discharged without any treatment or after a primary treatment only. In Philippines, only 1% of the total population is connected to a sewer network. The vast majority uses flush toilets connected to septic tanks. Since sludge treatment and disposal facilities are rare, most effluents are discharged without treatment. Philippines rely only on conventional methods to treat domestic and industrial water as advanced treatment methods are expensive to use and operate. Water utilities in the country are underfunded because of law tariffs and also, poor enforcement of environmental standards.

6.2. Nonpoint sources

Because NPS pollution came from diffuse sources such as urban and agricultural runoff, regulation of affected water bodies is difficult. Currently, NPS pollution is the leading cause of water pollution in United States. Conventional stormwater systems turned out to be not cost-effective and unable to meet the water quality goals. The NPS management in United States applies Best Management Practices (BMPs) in treating and managing stormwater runoff. The idea behind these systems are to try replicate natural systems that use cost effective solutions with low environmental impact to drain away dirty and surface water run-off through collection, storage, and cleaning before allowing it to be released slowly back into the environment. Frequently-used practices include litter traps, swales, infiltration trench, bio-retention systems, wetland, porous paving, rain gardens, rain water tanks and rooftop greening. BMP is similar to Sustainable urban Drainage Systems (SUDS) in the United Kingdom and Water Sensitive Urban Design (WSUD) in Australia. These water treatment systems are also adapted by Asian countries like Japan and South Korea. However, in Philippines, no facilities were constructed to treat urban and agricultural runoff. Polluted waters flow directly into sewers and is discharged directly into receiving water bodies.

7. Conclusions and recommendations

The Philippines has a total of 28 major river basins, 421 principal rivers, 79 lakes and a coastline of about 17,460 km. As of 2005, only 238 water bodies are monitored by EMB for classification and water quality. Monitoring results showed that the four urban critical regions in terms of water quality and quantity are NCR, Region III, V and VIII. Only less than half of the country's rivers are classified as a good source of public water supply. A total of 129 wells were monitored for fecal coliform contamination and 58% were found to be not safe to be used for drinking and needs treatment while most of the beaches passed the fecal coliform criterion. Most of the stations which failed are from Region III because improper waste management practices by the communities and beach resort operators along the coastal area. EMB monitoring results revealed that domestic wastes are the major source of pollution (33%), followed by livestock (29%) and industrial sources (27%). NPS pollution accounts for 11% of the organic load contribution to water bodies. Only 1% of the total population is connected to a sewer network. The vast majority uses flush toilets connected to septic tanks. Since sludge treatment and disposal facilities are rare, most effluents are discharged without treatment.

Compared to other countries, Philippines is way behind in terms of water treatment facilities and sewage connection services. To improve the quality of its surface, ground and coastal waters, 5 strategies should be pursued. First, a systematic and massive environmental education must be pursued to elevate the level of consciousness of the entire citizenry regarding environmental issues, and health and economic impacts of poor water quality. Environmental activities should be taught in schools at all levels as well as in the programs of the different government agencies, NGOs and the private sectors. Second, to improve wastewater management there should be a complete coverage of sewage service in all areas in the country and also, construction of sewage treatment facilities in urban and tourist areas. Currently, no treatment facility was constructed to treat stormwater runoff from urban and agricultural areas. It is very important to have a treatment facility for NPS considering that it is one of the major contributors in water pollution.

Third, inadequate sewage facility in the country is a result of lack of funding by the Local Government Units (LGU). There is a need for Local Government Units (LGU) to demand and collect reasonable fee to support the operation and maintenance costs of sewerage facilities. In addition, strengthening of the Environmental User Fee System (EUFS) adapted from the "polluters pay principle" requiring commercial, industrial and agro-based industries to pay for the amount of discharge of wastewaters in the receiving water body. It will encourage polluters to decrease their wastewater discharge. Fourth, regular monitoring and inspection must be performed to ensure compliancy of wastewater-producing establishments and to determine the current water status of all critical water bodies. Lastly, support to research and development should be strengthened especially researches concerning new BMPs that are practiced by developed countries. It provides significant data, impact assessment, predictive tools and treatment systems that may be changed to adjust the specific conditions of the country. Furthermore, these studies could contribute to the improvement of the environmental policies and laws.

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