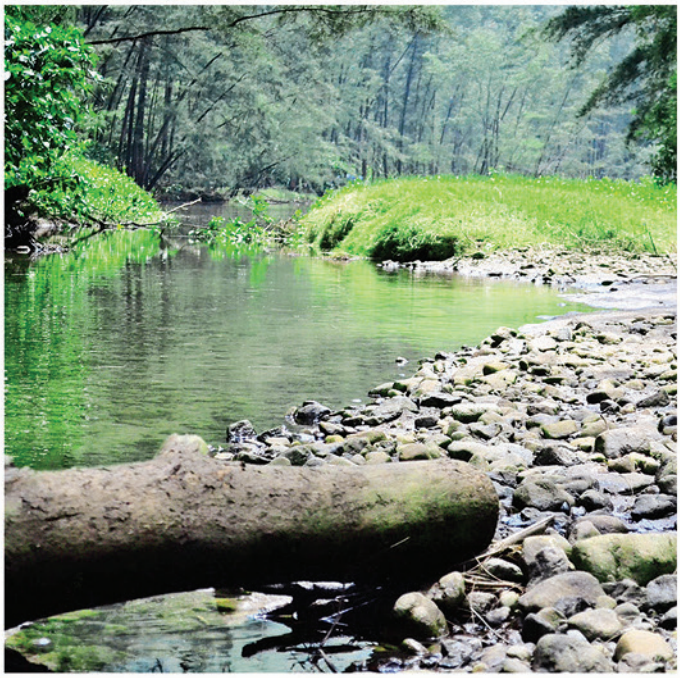
NATIONAL WATER QUALITY STATUS REPORT 2006-2013



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MESSAGE

Water plays a central and critical role in all aspects of life. It is essential to our health, and our agricultural and industrial enterprises. The challenge, therefore, is to ensure, that we have sufficient and clean water to supply our needs. The focus on our water resources is often on the volume of water available for particular purposes. However, water quality is equally important as it determines the suitability of water for a particular purpose.

The reality is that most of our cities and municipalities are situated along rivers, lakes, and coastal areas. The quality of these water resources is under constant threat from harmful and damaging effects of human activity. Water pollution has increased greatly over the years with the growth of population and the economy.

This behooves us in the department to monitor ever vigilantly the quality of water bodies on which nothing less than our very sustenance depends. To facilitate this, we have prepared the National Water Quality Status Report. It is my hope that this second comprehensive edition, which aims to inform various stakeholders of the status of our water bodies as well as provides updates on the implementation of the Philippine Clean Water Act during the last eight years, will go a long way in supporting efforts to work for the continued protection and conservation of our precious water resources.

Mabuhay!

HON. RAMON J.P. PAJE
Secretary, DENR

FOREWORD

The country's water resources are of major environmental, social, and economic values. A greater part of our towns is situated in coastal areas and relies heavily on marine fishing and trade for livelihood. However, the quality of these water resources is continuously threatened by the detrimental effects of human activities and their by-products.

The protection, preservation, and rehabilitation of these water resources are mandated through the Philippine Clean Water Act of 2004. Since its enactment, the Department of Environment and Natural Resources (DENR) has implemented a number of water quality management activities, including the preparation of the National Water Quality Status Report (NWQSR). In the fight against environmental degradation, this NWQSR (2006-2013) will serve as the main reference for addressing the latest challenges and resolving ongoing issues on water resource management. The overall objective of the Report is to inform the public and the various stakeholders on the current status of water bodies in our country and present the progress of water quality management since 2006. By doing so, the Report seeks to advocate support and active participation from partner agencies in improving or maintaining the quality of these water bodies at their most beneficial use so as to sustain the economic growth and development of our country.

This Report is a manifestation of the hard work, dedication, and persistence of partner agencies to protect our natural resources and public health as responsible citizens of our country, and moreover, as good stewards of the environment.

On behalf of the Environmental Management Bureau (EMB) of the DENR, we would like to extend our sincerest appreciation to all our partners who have unselfishly contributed to the development of this Report. To the Technical Working Group, thank you very much for your diligence and hard work. Your endeavor in collating and analyzing the eight-year data and documenting our policies and programs is highly commendable.

Let us all continue to work together to preserve the beauty and richness of our water bodies!

ATTY. JONAS R. LEONES
Undersecretary, DENR
and Concurrent Director, EMB-DENR

PREFACE

This *National Water Quality Status Report (2006-2013)* was prepared in compliance with the provisions of the Philippine Clean Water Act of 2004. In continuation of the *First National Water Quality Status Report (2001 to 2005)*, this second edition aims to update and sustain the awareness of the general public on water quality management issues with the end goal of advancing multi-sectoral support to improve the Philippine water quality.

The Report, covering an eight-year period from 2006 to 2013, evaluates the status of the water quality in the Philippines in accordance with its envisioned beneficial uses. It provides an overview of the country's water resources and presents the general state of water quality based on the assessment of monitored significant parameters, including the identification of pollution sources and extent of contamination in the monitored water bodies.

This *National Water Quality Status Report (2006 to 2013)* also summarizes the water-related incidents that have affected public health or impacted the country's water quality and highlights the policies, programs, and best practices being implemented to address water pollution issues. More importantly, this Report presents the various challenges experienced by the country and areas for improvement in preventing water pollution and in protecting the quality of our water bodies.

The preparation and development of the *National Water Quality Status Report (2006-2013)* was in accordance with the DENR-EMB *Guideline for the Preparation of the Regional and National Water Quality Status Reports for Public Information and Advocacy*. Review workshops by the Technical Working Group and consultations with stakeholders were also conducted as part of the development process of this Report.

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ACRONYMS & ABBREVIATIONS

ADB	Asian Development Bank
AO	Administrative Order
BFAR	Bureau of Fisheries and Aquatic Resources
BMB	Biodiversity Management Bureau
BOD	Biochemical Oxygen Demand
CWA	Clean Water Act
DA	Department of Agriculture
DAO	DENR Administrative Order
DENR	Department of Environment and Natural Resources
DLSU	De La Salle University
DMC	DENR Memorandum Circular
DO	Dissolved Oxygen
DOH	Department of Health
DOST	Department of Science and Technology
DPWH	Department of Public Works and Highways
DRRM	Disaster Risk Reduction and Management
EIA	Environmental Impact Assessment
EMB	Environmental Management Bureau
EO	Executive Order
GIS	Geographic Information System
IEC	Information, Education, and Communication
IRR	Implementing Rules and Regulations
ITDI	Industrial Technology Development Institute
IWQMF	Integrated Water Quality Management Framework
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
LGU	Local Government Unit
LISCOP	Laguna de Bay Institutional Strengthening and Community Participation
LLDA	Laguna Lake Development Authority
MC	Memorandum Circular
MGB	Mines and Geosciences Bureau
MTSP	Manila Third Sewerage Project
MWCI	Manila Water Company, Inc.
MWSI	Maynilad Water Services, Inc.
NGO	Non-Government Organization
NOV	Notice of Violation
NSSMP	National Sewerage and Septage Management Program
NWRB	National Water Resources Board
PAB	Pollution Adjudication Board
PCB	Polychlorinated Biphenyls
PCG	Philippine Coast Guard
PCIEERD	Philippine Council for Industry, Energy, and Emerging Technology Research and Development
PCO	Pollution Control Officer
PNSDW	Philippine National Standards for Drinking Water
PRRC	Pasig River Rehabilitation Commission
RA	Republic Act
RBCO	River Basin Control Office
SpTP	Septage Treatment Plant
STP	Sewage Treatment Plant
TSS	Total Suspended Solids
USAID	United States Agency for International Development
WB	World Bank
WQMA	Water Quality Management Area
WWDP	Wastewater Discharge Permit

DEFINITION OF TERMS

Beneficial Use. Use of the environment or any element or segment thereof, conducive to public or private welfare, safety and health; and shall include, but not be limited to, the use of water for domestic, municipal, irrigation, power generation, fisheries, livestock raising, industrial, recreational, and other purposes.

Biochemical Oxygen Demand. Measures the approximate concentration of dissolved oxygen required by bacteria or micro-organisms to decompose organic matter in wastewater or surface water.

Coastal Water. Open water body along the country's coastline, starting from the shoreline and extending outward up to 200 meter isobaths or three kilometer distance, whichever is farther.

Contamination. Introduction of materials not normally found in water that make the water less desirable or unfit for its intended use.

Cyanide (as Free Cyanide). Any substance containing the cyanide ion as found in metallic cyanide and hydrogen cyanide.

Dissolved Oxygen (DO). Measures the concentration of oxygen dissolved in water. The higher the DO, the better the condition for the growth and productivity of aquatic resources.

Effluent. Discharge from a known source, which is passed into a body of water or land, wastewater flowing out of a manufacturing plant, industrial plant, including domestic, commercial, and recreational facilities.

Fecal Coliform. Subgroup of coliform bacteria that has a high positive correlation with fecal contamination associated with all warm-blooded animals.

Freshwater. Water containing less than 500 parts per million dissolved common salt, sodium chloride, such as that in groundwater, rivers, and lakes.

Groundwater. Subsurface water that occurs beneath a water table in soils and rocks, or in geological formations.

Heavy Metals. Collective term for metals of high atomic mass, particularly those transition metals, such as lead, mercury, and cadmium, that are toxic and cannot be processed by living organisms.

Inland Water. All standing or flowing water on the surface of the land (such as reservoirs, lakes, and rivers) and all groundwater on the landward side of the baseline from which the breadth of territorial waters is measured.

Lake. Inland body of water, an expanded part of a river, a reservoir formed by a dam, or a lake basin intermittently or formerly covered by water.

Major River Basin. River basins with at least 1,400 square kilometers (sq km) of drainage area.

Marine Water. Water with salinity levels not less than 30 parts per thousand, at least 95 percent of the time.

Nitrates. Include nitrate salts of ammonium, sodium, potassium, and calcium. These come from soil fertilizers during agricultural runoff as well as in sewage discharge and septic systems, where they are formed as by-products of the decomposition of animal or human wastes.

Non-point Source. Any source of pollution not identifiable to as a point source, such as runoff from irrigation or rainwater that picks up pollutants from farms and urban areas.

Phosphates. Measure the quantity of phosphorus present as phosphates. It is a common constituent of fertilizers and organic wastes in sewage and industrial effluent.

Point Source. Any identifiable source of pollution with specific point of discharge into a particular water body.

Pollution Load. Amount of pollutant being discharged into the environment; the product of the wastewater quality or concentration and the volumetric rate of discharge.

Principal River Basin. River basins with at least 40 sq km of drainage area.

River Basin. Horizontal projection of area from which a stream or lake receives surface water originating as precipitation.

Runoff. Portion of rainfall or irrigation water that flows across the ground's surface and is eventually returned to streams.

DEFINITION OF TERMS

Salinity. Measures the salt concentration of water, usually measured in parts per thousand.

Sanitation. Improvement of environmental conditions in households that affect human health by means of drainage and proper disposal of sewage and refuse.

Septage. Sludge produced in individual on-site wastewater disposal systems, such as septic tanks.

Septic Tank. Watertight receptacle which receives the discharge of a plumbing system, and is designed to accomplish the partial removal and digestion of the suspended solid matter in the sewage through a period of detention.

Sewage. Waterborne human or animal wastes, excluding oil or oil wastes, removed from residences, buildings, and industrial and commercial establishments.

Sewerage. Any system or network of pipelines, ditches, or conduits including pumping stations, lift stations, and service connections and devices, which involves the collection, transport, pumping, and treatment of sewage to the point of disposal.

Surface Water. All waters open to the atmosphere and subject to surface runoff.

Total Coliform. Group of bacteria with common characteristics used to indicate water quality; includes bacteria found in soil, in water influenced by surface water, and in human and animal wastes.

Total Suspended Solids. Concentration of undissolved solid particles in water (e.g., silt, decaying plant and animal matter, and domestic and industrial wastes), which is indicative of the extent of sedimentation resulting from land-based activities.

Wastewater. Waste in liquid state containing pollutants.

Water Body. Both natural and human-made bodies of fresh, brackish, and saline waters, and includes, but is not limited to, aquifers, groundwater, springs, creeks, streams, rivers, ponds, lagoons, water reservoirs, lakes, bays, estuarine, and coastal and marine waters. Water bodies do not refer to those constructed, developed, and used purposely as water treatment facilities and/or water storage for recycling and re-use, which are integral to process industry or manufacturing.

Water Body Classification. Categorization of water bodies taking into account, among others, the following: (1) existing quality of the water body; (2) size, depth, surface area covered, volume, direction, flow rate, and stream gradient; (3) most beneficial existing and future use of the said water body and its surrounding land; and (4) vulnerability of surface and groundwater to contamination from pollutive sources.

Water Quality. Characteristics of water that define its use in terms of physical, chemical, biological, bacteriological, or radiological characteristics by which the acceptability of water is evaluated.

Water Quality Criteria/Guideline. The level for a water constituent or numerical values of physical, chemical, biological and bacteriological or radiological parameters which are used to classify water resources and their use, which do not result in significant health risk and which are not intended for direct enforcement but only for water duality management purposes, such as determining time trends, evaluating stages of deterioration or enhancement of the water quality, and as basis for taking positive action in preventing, controlling, or abating water pollution.

Water Quality Management Area. Certain areas designated using appropriate physiographic units (i.e., watershed, river basins, or water resources regions), having similar hydrological, hydrogeological, meteorological, or geographic conditions which affect the physiochemical, biological, and bacteriological reactions and diffusions of pollutants in the water bodies, or otherwise share common interest or face similar development programs, prospects, or problems.

EXECUTIVE SUMMARY

The Philippines has come a long way in protecting, preserving, and reviving the quality of its water bodies since the enactment of Republic Act 9275 or the Philippine Clean Water Act of 2004. Endowed with 18 major river basins, 421 principal rivers, 79 natural lakes, and an extensive coastline of 36,289 kilometers, the country must continue the protection of these resources to ensure sustainable development. Although there are still challenges ahead, several activities have been initiated through the leadership of the Department of Environment and Natural Resources (DENR), one of which is the continuing preparation and publication of a National Water Quality Status Report.

This National Water Quality Status Report (2006 to 2013) presents the state of the Philippine water quality and highlights the activities and programs of DENR and the different institutions on water quality management. The Report aims to inform various stakeholders of the status of our country's water bodies, and consequently, encourage their active participation in the protection of these water resources.

As of 2013, the Environmental Management Bureau (EMB) of the DENR has classified a total of 688 water bodies according to their intended beneficial usages as specified in DENR Administrative Order 1990-34. This constitutes 313 principal rivers, 301 minor rivers, 16 lakes, and 58 coastal and marine waters.

Out of the 688 classified water bodies, 167 have multiple classifications along their stretches or reaches, thus leading to a total of 874 classifications. Of these, five are Class AA and 234 are Class A, which are both intended for public water supply. Majority of the water bodies are classified as Class C, which are intended for fishery, recreation, and supply for manufacturing processes after treatment. A large number of water bodies are also classified as Class B, which are intended for recreational activities involving primary contact such as bathing, swimming, and skin diving.

Of the 58 classified coastal and marine waters, only five are Class SA, which are designated as protected marine habitat. Majority are Classes SB and SC, which are intended for contact recreation and aquaculture production, respectively.

From 2006 to 2013, the EMB, through its Regional Offices, monitored 199 water bodies, which account for 29 percent of the 688 water bodies classified. Among these, 135 inland surface waters and 21 coastal and marine waters were monitored for regular water quality monitoring. The remaining 43 water bodies were monitored for classification or reclassification purposes. Table ES-1 presents the number of water bodies inventoried, classified, and monitored from 2006 to 2013.

Table ES- 1. Statistics on Water Quality Management, 2013.

Water Quality Management Field	Achievement as of 2013
Number of water bodies inventoried	1,030
Number of water bodies classified	688
Number of water bodies monitored	199

Source: EMB, 2013.

The key water quality parameter used in monitoring of surface waters is dissolved oxygen (DO). Depending on the beneficial usage and potential pollution sources of the water body, other water quality parameters are also used in the assessment. These include:

- Biochemical Oxygen Demand (BOD)
- Total Suspended Solids (TSS)
- Phosphates
- Nitrates
- Heavy Metals
- Free Cyanide
- Fecal Coliform
- Total Coliform

For groundwater, fecal coliform, nitrates, and salinity (chloride content) are the common parameters used for water quality assessment. Results of the monitoring showed that only 42 percent of the inland surface waters that were monitored for regular water quality monitoring passed the criteria for DO and BOD. Notably, only one priority river (Cagayan de Oro River in Region 10) exhibited 100 percent compliance to both criteria. In contrast, priority rivers located in NCR, CAR, and Region 3 had the lowest DO and BOD compliance ratings.

Of the 40 water bodies monitored as sources of drinking water supply, only 28 percent conformed to the criterion for TSS, signifying the effects of sand and gravel quarrying activities and runoff sediments from denuded forests and agricultural lands. Moreover, only 27 percent of those



EXECUTIVE SUMMARY

monitored for both phosphates and nitrates were fully compliant with their corresponding criterion. Water bodies monitored for toxic chemicals such as cyanide and heavy metals (mercury, lead, and cadmium) are limited and focused only on those water bodies with remarkably known sources of these pollutants. Monitoring results showed that half of the eight water bodies monitored for cyanide achieved 100 percent compliance rating. On the other hand, of the water bodies monitored for heavy metals, 83 percent, 44 percent, and 39 percent showed 100 percent compliance rating to the criterion for mercury, cadmium, and lead, respectively.

Water quality assessment of coastal and marine waters showed that 38 percent consistently met the DO criterion. Most of these are Class SB and Class SC, which are intended for recreation and fishing activities, respectively. Significantly, only 13 percent remained compliant with the prescribed criterion for Fecal Coliform and Total Coliform. These are Puerto Princesa Bay in Region 4B and the coastal waters of Boracay in Region 6, both of which are Class SB. In contrast, Coron Bay in Region 4B failed to meet both the Fecal Coliform and Total Coliform criteria throughout the entire monitoring period.

Rapid inventory of point sources revealed that the agricultural sector had the highest contribution, accounting for 45 percent of the total pollution load. This is followed by the domestic and industrial sectors with 31 percent and 24 percent, respectively. On the other hand, non-point sources of pollution include agricultural runoff, which contributes 61 percent of the total pollution load; urban runoff with 29 percent, and forest runoff with 10 percent.

In response to the growing issues and concerns in water quality management, the government has implemented national policies and regulations as well as ordinances from provincial, municipal, or city governments in support of the Philippine Clean Water Act of 2004. Programs, projects, and activities have been spearheaded by government agencies, non-government organizations, private institutions, and the academe in a collaborative effort to control water pollution and protect the country's water bodies. Noteworthy of these programs include:

- Continuing monitoring and enforcement of water quality regulations
- Implementation of Adopt-an-*Estero*/ Water Body Program
- Designation of 17 water quality management areas (WQMA)
- Implementation of the Industrial EcoWatch Program
- Implementation of the Beach Watch Program
- Formulation of a Philippine Integrated River Basin Management and Development Framework Plan
- Implementation of watershed management programs
- Conduct of Groundwater Resources and Vulnerability Assessment
- Establishment of the National Sewerage and Septage Management Program
- Establishment of an Integrated Water Quality Management Framework
- Investments in sanitation, sewerage, and wastewater treatment spearheaded by development partners and private institutions
- Various research and development initiatives on water quality management from DENR, the Department of Science and Technology, and the academe

Despite the significant improvements in the implementation of the Philippine Clean Water Act of 2004, the expected outcomes are still insufficiently realized as the country is still faced with the following key challenges:

- Inventory of Water Bodies
- Classification of Water Bodies
- Monitoring of Water Bodies
- Provision of Sufficient Resources to Implement Water Quality Management
- Assessment of Groundwater Quality
- Enforcement of Water Quality Regulations
- Establishment of Soil Erosion Control Programs
- Control of Coliform Contamination
- Control of Mercury and Cyanide Contamination
- Improvements in Sewerage and Sanitation
- Encroachment of Informal Settlements along Water Bodies
- Implementation of Effective Solid Waste Management System
- Mitigating the Effects of Climate Change on Water Resources
- Sustaining Awareness Campaign and Public Private Partnership

1 CHAPTER

INTRODUCTION

Lake Ambulalakaw, Benguet

Source: Ma. Elizabeth Morada

This National Water Quality Status Report (2006 to 2013) is prepared by the Department of Environment and Natural Resources (DENR), through the Environmental Management Bureau (EMB), in accordance with Section 19.a of Republic Act (RA) 9275, also known as the Philippine Clean Water Act (CWA) of 2004. The Report presents the following:

- Profile of the country's water resources
- General state of water quality evaluated through the assessment of monitored significant water quality parameters and identification of pollution sources
- Water quality management policies and programs
- Best practices and lessons learned in water quality management
- Challenges and areas for improvement in protecting and/or enhancing the quality of water bodies in the country

1.1 GEOGRAPHY

The Philippines is an archipelago consisting of 7,107 islands, which are grouped among the three major island divisions, namely: Luzon, Visayas, and Mindanao. Several water bodies surround the country with Luzon Strait on its northern portion, Pacific Ocean on its eastern side, West Philippine Sea on its western side, and Celebes Sea on its southern portion.

The country has a land area of 300,000 square kilometers (sq km) and is politically divided into 17 administrative regions. These are:

- National Capital Region (NCR) – Metro Manila
- Cordillera Administrative Region (CAR)
- Region 1 – Ilocos
- Region 2 – Cagayan Valley
- Region 3 – Central Luzon
- Region 4A – CALABARZON
- Region 4B – MIMAROPA
- Region 5 – Bicol
- Region 6 – Western Visayas
- Region 7 – Central Visayas
- Region 8 – Eastern Visayas
- Region 9 – Western Mindanao
- Region 10 – Northern Mindanao
- Region 11 – Southern Mindanao
- Region 12 – Central Mindanao
- Region 13 – Caraga
- Autonomous Region of Muslim Mindanao (ARMM)

1.2 CLIMATE

The Philippines sits proximate to the equator, thus its climate is considered as tropical and maritime. This climate is characterized by relatively high temperature, high humidity, and abundant rainfall.

The warmest month is May, during which temperature averages 28.3°C, while the coolest month is January, during which temperature averages 25.5°C. Humidity is relatively high due to the inherently high temperatures and the surrounding waters serving as a source of moisture. As a result, humidity ranges from 71 to 85 percent.

The country generally experiences two major seasons – dry season from December to May, and wet season from June to November. The wet season is characterized by frequent rainfalls, during which distribution varies from one region to another. Within a 30-year period from 1981 to 2010, rainfall averaged from 960 to 4,465 millimeters annually. Based on the annual rainfall distribution, the climate of the Philippines is classified according to the Corona's four types of climate. These are:

- Type I – Dry season from November to April, and wet season during the rest of the year
- Type II – No dry season with a very pronounced rainfall from November to April, and wet season during the rest of the year
- Type III – Relatively dry season from November to April, and wet season during the rest of the year
- Type IV – Rainfall is more or less distributed throughout the year

1.3 DEMOGRAPHY

The 2010 population of the Philippines is 92.3 million, making it the seventh most populous country in Asia and the twelfth worldwide.

Among the 17 administrative regions, Region 4A is the most populated with 12.6 million. This is closely followed by NCR and Region 3 with 11.9 million and 10.1 million, respectively. These three neighboring regions in Luzon comprise more than one-third of the national population.

Population affects the surrounding water bodies as waste generation is directly proportional to the number of people. Wastes are inadvertently thrown into rivers, *esteros*, lakes, and coastal waters, thereby affecting water quality. Improper waste management is more evident among residents along rivers and *esteros* who have inadequate sanitation.

The Homeless International Organization statistics estimated that the number of homeless individuals in the country is at 22.8 million, representing almost one-fourth of the national population. These residents build temporary shelters, mostly along unoccupied banks of rivers and *esteros*; and dispose wastes improperly.

1.4 ECONOMY

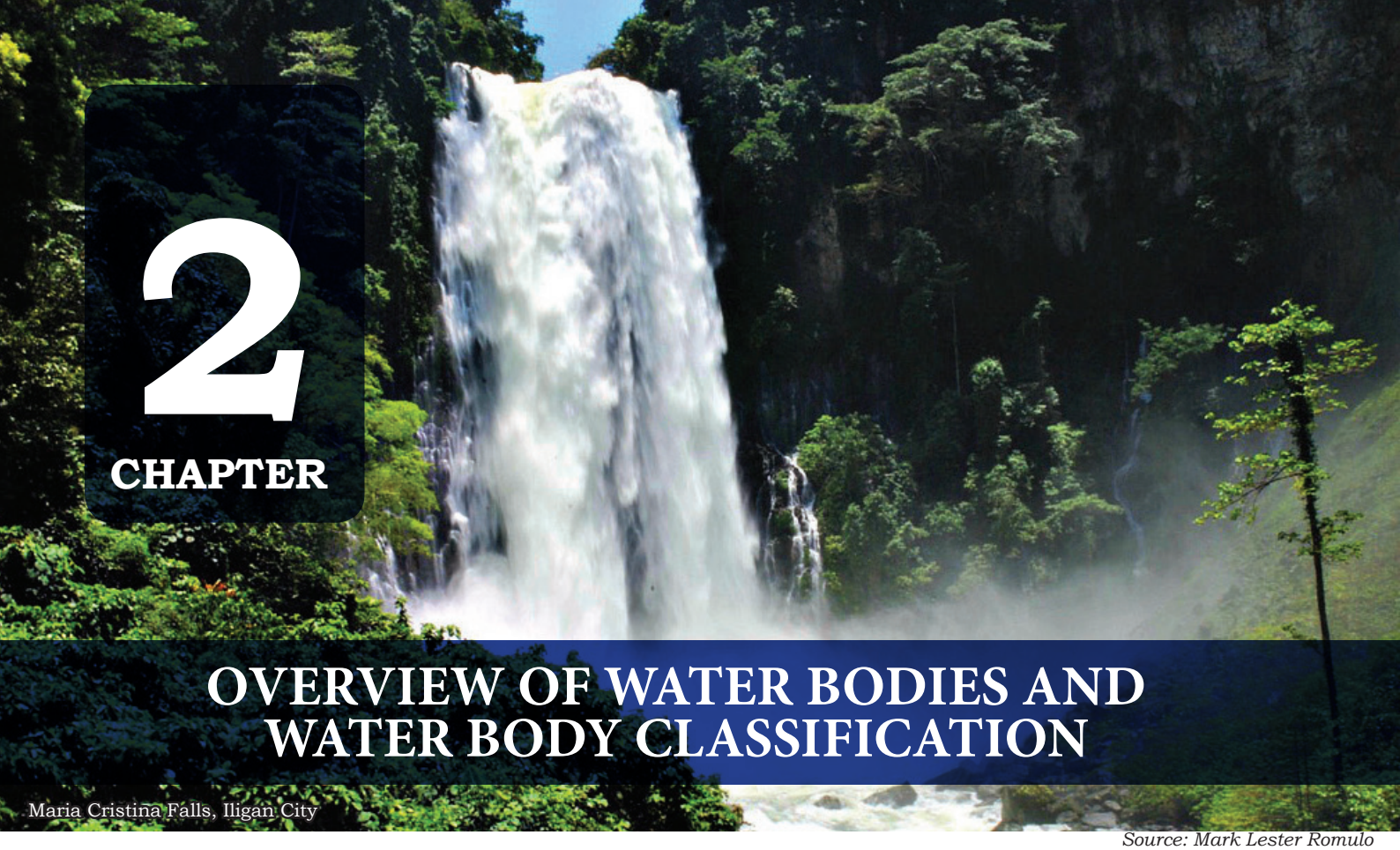
The country's rich water resources prove crucial to the country's economy. This becomes readily apparent when viewing the country's dependence on activities and industries, which actively utilize water bodies and their proponents, i.e. the industrial sector for water's cooling properties and its use as raw material; the agricultural sector for its use of water as an immutable necessity in cultivation. However, among these applications, the most pronounced may be those of the fishing sector.

As an aspect of Philippine water resource utilization, the fishing sector relies on the natural availability of edible sea-dwelling creatures within the country's territorial waters, and the development and application of appropriate technology to render them fit for human consumption or utilization. In addition, the sector contributes to the economy through the provision of jobs for a substantial percentage of the workforce, and through the extraction of seafood and related items, rendering their exportation possible. Specifically, the sector provided a total of 1,614,368 individuals with employment in 2002. Furthermore, exportation netted the country a total profit of US$ 720 million dollars in 2012.

The fishing sector is subdivided into municipal fishing, which is done with or without boats of three gross tons or less; commercial fishing, which uses vessels heavier than that of municipal; and aquaculture, which includes production from fishponds and mariculture. Of these, aquaculture proved to be the most valuable (contributing 42.5% of the whole sector's value) in 2013.

As a whole, the fishing sector's contribution to the Gross Domestic Product amounted to 1.73 percent in 2013, equivalent to a monetary value of PhP 199.32 billion out of the total of PhP 11.54 trillion at current price. This demonstrated productivity is strongly dependent on the quality of water resources in the country. Therefore, the effects of deteriorating water quality devalue the country's economic performance not only through the fishing sector, but also through dependent facets of the industry.

With focus on the country's economic development, the conservation of natural resources, especially water resources, is prioritized under the Philippine Development Plan for 2011 to 2016. Among the aimed outcomes in line with the conservation, protection, and rehabilitation of water resources are sustainable management of forests and watersheds; enhanced management of coastal and marine resources; reduction of water pollution; reduction of waste generation; and improvement of waste disposal.



2 CHAPTER

OVERVIEW OF WATER BODIES AND WATER BODY CLASSIFICATION

Maria Cristina Falls, Iligan City

Source: Mark Lester Romulo

This section introduces the water resources in the Philippines as well as summarizes the progress of EMB on water body classification.

2.1 WATER RESOURCES

Being an archipelago, the Philippines is naturally endowed with major river basins, lakes, coastal and marine waters, and groundwater. The ensuing discussions give an overview of these water resources.

2.1.1 Major River Basins

The country has 18 major river basins (Table 1) and 421 principal rivers as defined by the National Water Resources Board (NWRB). The area occupied by the river basins is 108,923 sq km, which represents more than one-third of the country's total land area.

The largest river basin is Cagayan with a catchment area of 25,649 sq km. It encompasses CAR and Region 2 and the province of Aurora in Region 3. It is utilized for hydroelectric power as several dams/ power plants are built within its proximity. These are:

- Magat Multi-Purpose Dam
- Magat A and B Small Hydroelectric Plant
- National Irrigation Administration-Baligatan
- Tumauini Small Hydroelectric Plant
- Casecnan Hydroelectric Power Plant

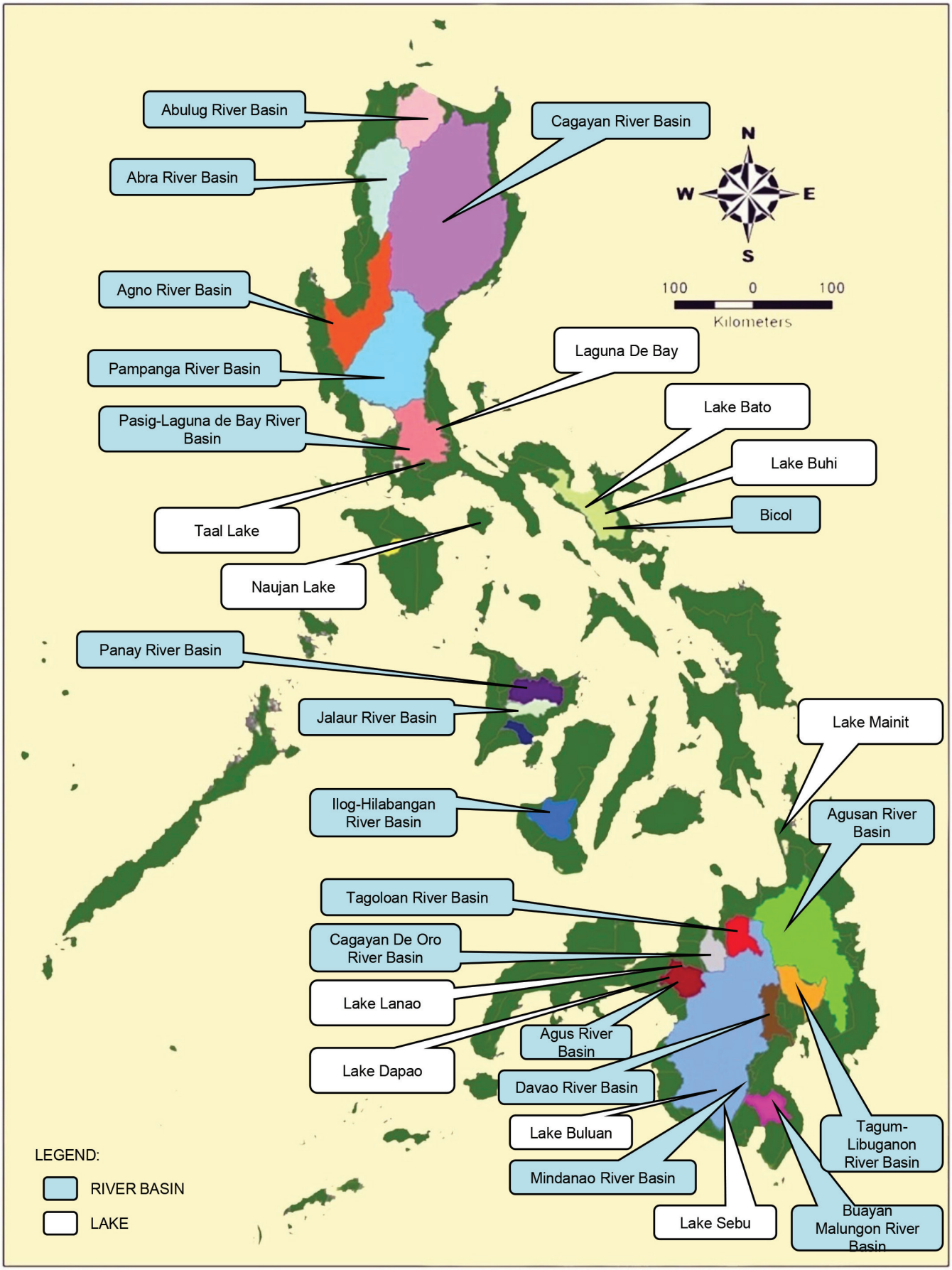
The second largest river basin is Mindanao, which is the largest in Mindanao. It has a catchment area of 23,169 sq km and encompasses Regions 10, 12, and ARMM. On the other hand, Ilog-Hilabangan is the largest river basin in the Visayas with a catchment area of 1,945 sq km and encompasses Regions 6 and 7. Figure 1 illustrates the location of the major river basins in the country.

Table 1. Major River Basins in the Philippines.

Name of River Basin	Catchment Area (sq km)	River Length (km)
Cagayan	25,649	505
Mindanao	23,169	373
Agusan	10,921	350
Pampanga	9,759	260
Agno	5,952	206
Abra	5,125	178
Pasig-Laguna de Bay	4,678	78
Bicol	3,771	136
Abulug	3,372	175
Tagum-Libuganon	3,064	89
Ilog-Hilabangan	1,945	124
Panay	1,843	132
Agus	1,890	36
Tagoloan	1,704	106
Davao	1,623	150
Cagayan de Oro	1,521	90
Jalaur	1,503	123
Buayan-Malungon	1,434	60
TOTAL	108,923	

Source: NWRB.

Figure 1. Location of Major River Basins and Lakes in the Philippines.



Source: NWRB, DA-BFAR, and RBCO, 2013.

2.1.2 Lakes

The Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture (DA) reports that there are 79 lakes in the country that are mostly utilized for fish production, with 10 (Table 2) of them considered as major host for aquaculture production.

Table 2. Major Lakes in the Philippines.

Name of Lake	Location	Area (sq km)
Laguna de Bay	Laguna and Rizal	900
Lanao	Lanao del Sur	347
Taal	Batangas	234
Mainit	Agusan del Norte & Surigao del Norte	140
Naujan	Oriental Mindoro	110
Buluan	Sultan Kudarat & Maguindanao	65
Bato	Camarines Sur	38
Buhi	Camarines Sur	18
Dapao	Lanao del Sur	10
Sebu	South Cotabato	9.64
TOTAL		1,871.64

Source: DA-BFAR, 2013.

Laguna de Bay, which is surrounded by NCR and Region 4A, is the largest among these lakes with a total area of 900 sq km. The lake encompasses the provinces of Laguna and Rizal; and some cities in Metro Manila. It is also considered as one of the five largest lakes in Southeast Asia. On the other hand, Lake Lanao is the largest lake in Mindanao with a total area of 347 sq km.

The locations of the 10 major lakes in the Philippines are also illustrated in Figure 1.

2.1.3 Coastal and Marine Waters

With numerous islands in the country, the coastal and marine waters cover an area of about 266,000 sq km. The country's coastline is at 36,289 km, making the Philippines the fourth in the world among countries with the longest stretch of coastlines as reported by the United States (US) Central Intelligence Agency.

The Philippines has an estimated 1,500 municipalities, and 70 percent of these are located in coastal areas, where the locals get their livelihood from. Of the four percent Gross National Income contribution of the fishing sector, 40 to 60 percent of this accounts to coastal fishing activities, which employ over a million Filipinos.

2.1.4 Groundwater

Groundwater is extensively used for domestic (drinking water) and irrigation purposes. From the 2013 statistics of NWRB, the total amount of registered water withdrawal from groundwater is estimated at 3.7 million cubic meters; of which 54 percent is used for domestic and 25 percent is used for irrigation. Regions with high groundwater utilization are Regions 3, 4A, 4B, 6, and 12.

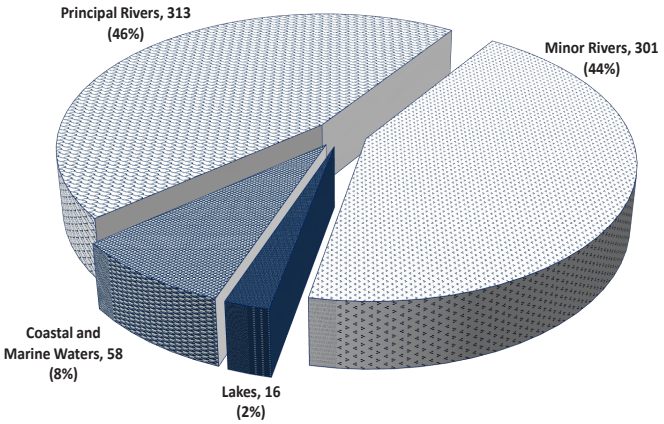
Furthermore, a 2006 study (*Simulating the Hydraulic Effects of Climate Change on Groundwater Resources in a Selected Aquifer in the Philippines Using a Numerical Groundwater Model*) by the Southeast Asian Regional Center for Graduate Study and Research in Agriculture simulated the effects of high temperature and low precipitation in a shallow aquifer in Laguna. Results showed that the groundwater level was incrementally declining at an average rate of 0.4 inch per year as annual precipitation decreased. In addition, by the end of 2050, groundwater levels are likely to decrease by 17 inches due to increasing domestic, agricultural, and industrial uses of groundwater as well as economic development in the area.

2.2 WATER BODY CLASSIFICATION

Water quality criteria are the benchmark for which monitoring data are compared to assess the quality of water bodies based on established classifications.

As of 2013, EMB has classified 688 water bodies in the country in terms of best usage and water quality. Of these classified water bodies, 313 are principal rivers, 301 are minor rivers, 16 are lakes, and 58 are coastal and marine waters. The breakdown of classified water bodies in the Philippines is presented in Figure 2.

Figure 2. Breakdown of Classified Water Bodies in the Philippines.



Source: DENR-EMB, 2013.

Since water bodies have several beneficial uses, these are sometimes classified differently per reach or portion of the water body. Of the 688 classified water bodies, 167 have multiple (two, three, or four) classifications. For example:

- Marikina River in NCR has two classifications: Class A in its upstream and Class C in its downstream
- Bacungan River in Region 4B has three classifications: Class A in its upstream, Class B in its midstream, and Class C in its downstream
- Lipadas River in Region 11 has four classifications: Class AA in its upstream, Classes A and B in its midstream, and Class C in its downstream

These sum up to a total of 874 classifications. Table 3 presents the breakdown per classification.

Table 3. Number of Water Bodies per Classification and Beneficial Use.

Classification	Beneficial Use	Number
	INLAND SURFACE WATERS	
Class AA	Public Water Supply Class I. Intended primarily for waters having watersheds which are uninhabited and otherwise protected and which require only approved disinfection to meet the Philippine National Standards for Drinking Water (PNSDW)	5
Class A	Public Water Supply Class II. For sources of water supply that will require complete treatment (coagulation, sedimentation, filtration, and disinfection) to meet the PNSDW	234
Class B	Recreational Water Class I. For primary contact recreation such as bathing, swimming, skin diving, etc. (particularly those designated for tourism purposes)	197
Class C	1) Fishery Water for the propagation and growth of fish and other aquatic resources 2) Recreational Water Class II (Boatings, etc.) 3) Industrial Water Supply Class I (For manufacturing processes after treatment)	333
Class D	1) For agriculture, irrigation, livestock watering, etc. 2) Industrial Water Supply Class II (e.g. cooling, etc.) 3) Other inland waters, by their quality, belong to this classification	27
	COASTAL AND MARINE WATERS	
Class SA	1) Waters suitable for the propagation, survival, and harvesting of shellfish for commercial purposes 2) National marine parks and marine reserves established under existing laws and/or declared as such by appropriate government agency 3) Coral reef parks and reserves designated by law and concerned authorities	5
Class SB	1) Tourist zones and marine reserves primarily used for recreational activities such as bathing, swimming, skin diving, etc. established under existing laws and/or declared as such by appropriate government agency 2) Recreational Water Class I (Areas regularly used by the public for bathing, swimming, skin diving, etc.) 3) Fishery Water Class I (Spawning areas for *Chanos chanos* or *Bangus* and similar species)	37
Class SC	1) Recreational Water Class II (e.g. boating, etc.) 2) Fishery Water Class II (Commercial and sustenance fishing) 3) Marshy and/or mangrove areas declared as fish and wildlife sanctuaries	35
Class SD	1) Industrial Water Supply Class II (e.g. cooling, etc.) 2) Other coastal and marine waters, by their quality, belong to this classification	1

Source: DENR Administrative Order (DAO) 1990-34 and DAO 1997-23.

Of the classified inland surface waters, five are Class AA, 234 are Class A, 197 are Class B, 333 are Class C, and 27 are Class D. The five Class AA waters are:

- Nagan River (upstream) and Lake Ambulalakaw in CAR
- Ginabasan River (upstream) in Region 7
- Lipadas River (upstream) and Baganga-Mahan-Ub River (upstream) in Region 11

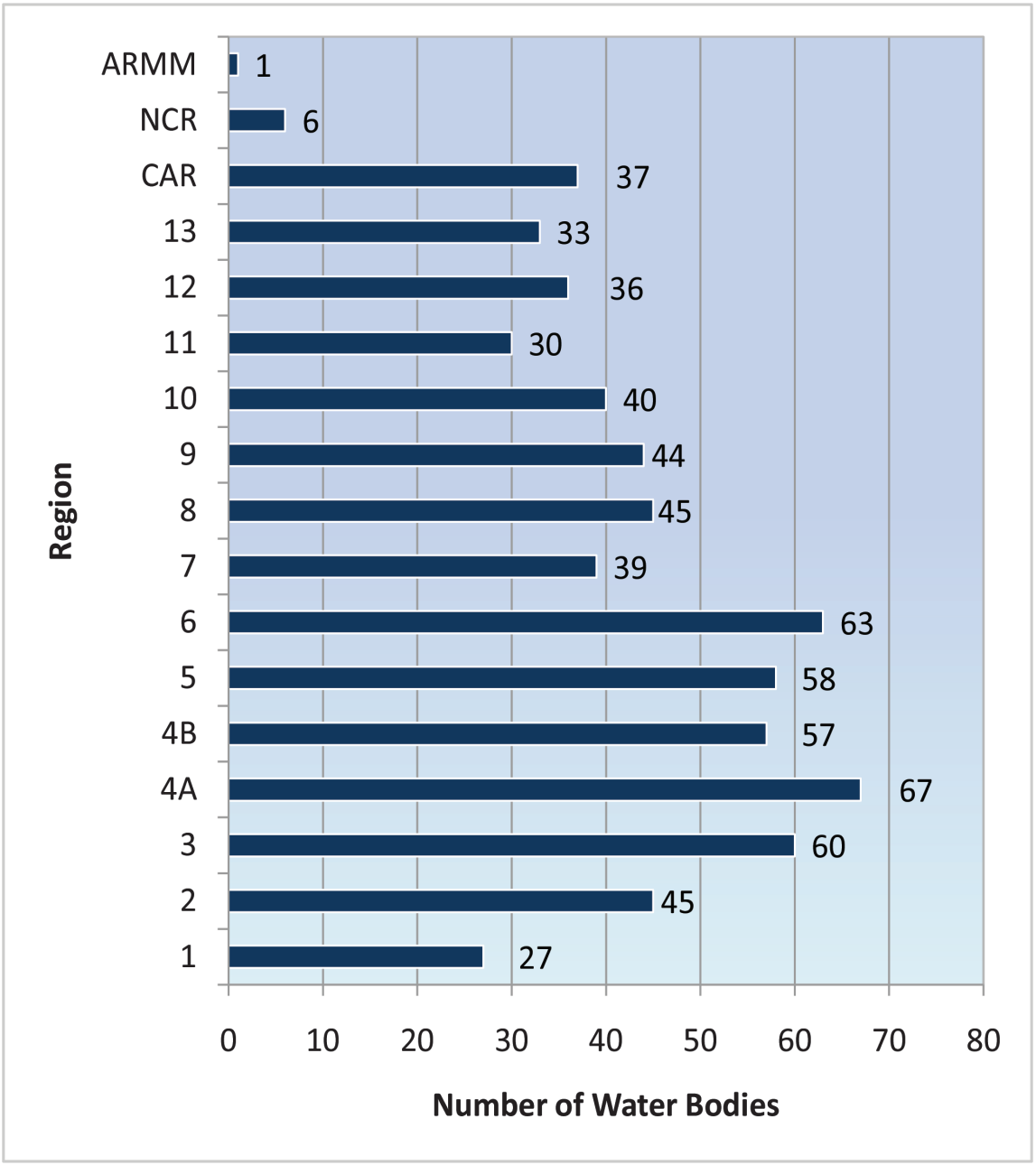
For the classified coastal and marine waters; five are Class SA, 37 are Class SB, 35 are Class SC, and one is Class SD.

The five Class SA waters are:

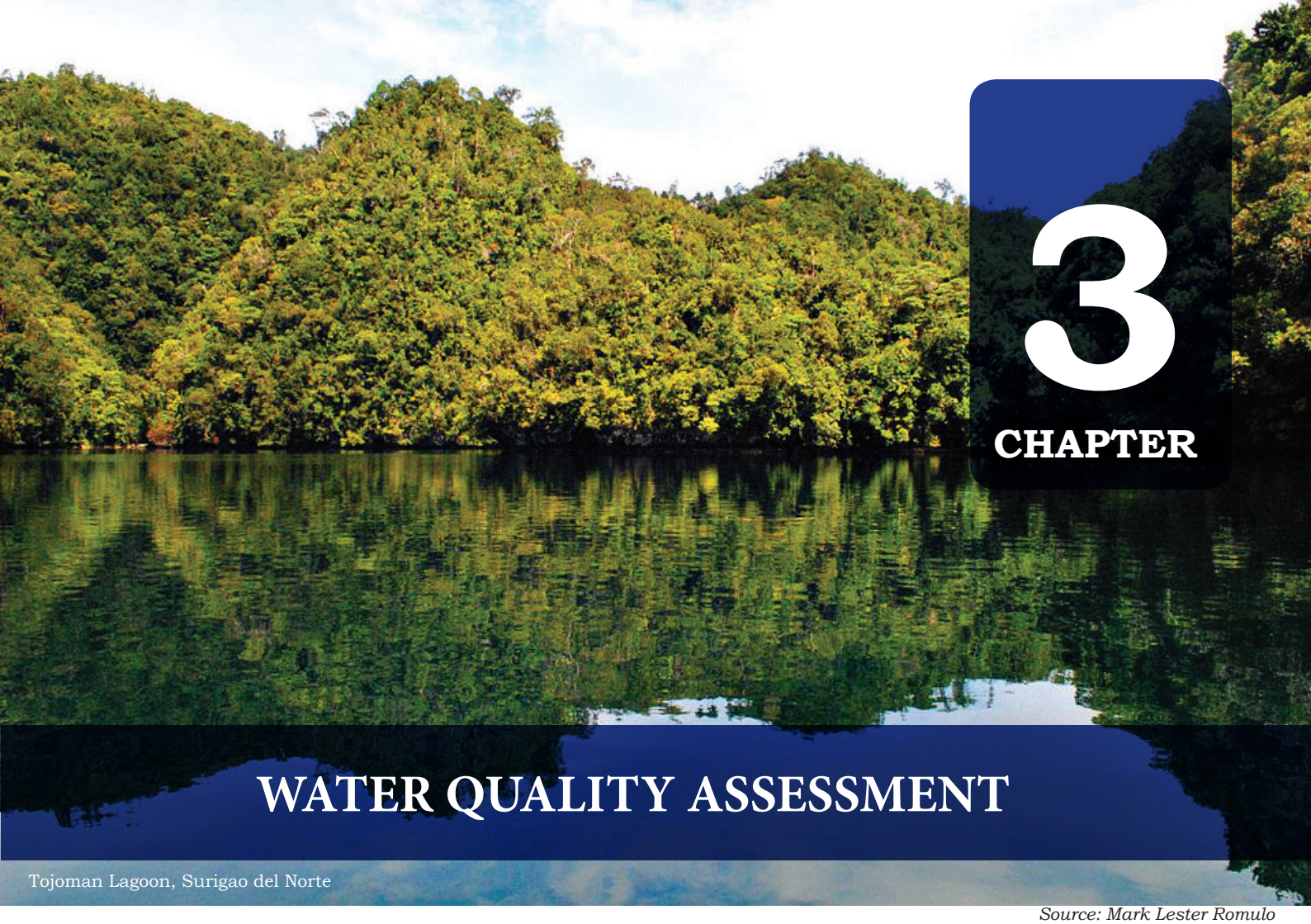
- Puerto Galera (Muelle Bay) and Bulalacao Bay in Region 4B
- San Jose Coastal Waters in Region 6
- Olango Channel in Region 7
- Taganito Bay in Caraga

Overall, Region 4A has the most number of classified water bodies with 67. This is followed by Region 6 with 63 and Region 3 with 60. On the other hand, NCR has the least with six as it has the least number of water bodies. Figure 3 presents the regional distribution of classified water bodies.

Figure 3. Distribution of Classified Water Bodies per Region.



Source: EMB, 2013.



CHAPTER 3

WATER QUALITY ASSESSMENT

Tojoman Lagoon, Surigao del Norte

Source: Mark Lester Romulo

Philippine water quality is assessed based on the set beneficial use as defined in DAO 1990-34. Under this DAO, there are 33 parameters that define the desired water quality per water body classification. Accordingly, a water body must meet the corresponding criteria of each applicable parameter 100 percent of the time to maintain its designated classification. In the absence of a water quality index, an interim methodology based on compliance to DAO 1990-34 is used for all surface waters. Table 4 presents the parameters monitored to assess the water quality per type of water body.

Table 4. Monitored Water Quality Parameters per Type of Water Body.

Water Body	Water Quality Parameter
Inland surface waters	• Dissolved oxygen (DO) • Biochemical oxygen demand (BOD) • Total suspended solids (TSS) • Phosphates • Nitrates • Heavy metals • Cyanide as free cyanide
Groundwater	• Fecal Coliform • Nitrates • Salinity (chloride content)
Coastal and marine waters	• Fecal Coliform • Total Coliform • DO

3.1 INLAND SURFACE WATERS

From 2006 to 2013, EMB monitored 135 inland surface waters, comprising of 55 principal rivers, 76 minor rivers, and four lakes. Of these, 26 were designated with multiple classifications. Hence, a total of 164 water body classifications were monitored within the eight-year period.

3.1.1 DO

DO is the concentration of oxygen measured in its dissolved form. Fish and other aquatic organisms require at least 5 milligrams per liter (mg/L) of dissolved oxygen to live. A DO level that is below this value cannot sustain the growth and productivity of aquatic life. Some factors that affect the concentration of DO in a water body are:

- *Water movement* – The more movement in water, the more oxygen is dissolved.
- *Temperature* – Low temperatures can hold oxygen more than high temperatures.
- *Pollution* – The higher the level of pollution, the lower the concentration of dissolved oxygen.

The methodology used for assessing and comparing water bodies is described in Box 1.

Box 1. Methodology for Assessing and Comparing Water Bodies.

Water bodies were assessed based on the number of samples meeting the DAO 1990-34 water quality criteria per parameter. Each parameter was monitored at a frequency prescribed in EMB Memorandum Circular (MC) 2008-08. The rating system used to assess and compare water bodies are shown below:

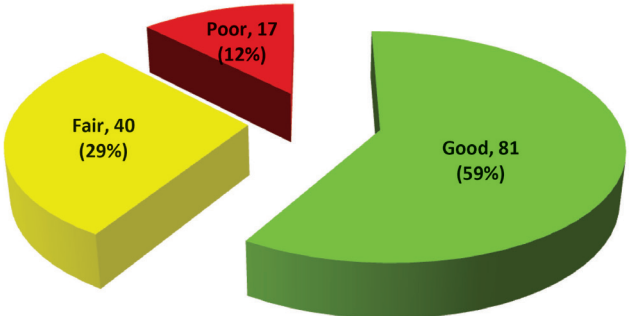
Rating	Percentage	Significance
Good	98-100	Water body complies with the desired water quality criteria and fully supports its intended beneficial use
Fair	50-97.99	Water body partially complies with the designated water quality criteria and is not supporting its intended beneficial use in 50 to 97.99% of sampling instances
Poor	0-49.99	Not able to support its intended beneficial use in 0 to 49.99% of sampling instances

Only water bodies with **at least four sampling events**, representing water quality during the dry and wet seasons, were included. The rating is based on the percentage of the total number of samples that passed the prescribed water quality criteria. A 98-percent margin is given to consider sampling and computation errors.

The results of water quality analysis are compared with the designated water quality criteria for each sampling station. This scheme harmonizes rating for all types of water bodies, particularly for those which have multiple water body classifications.

Of the 145 water body classifications or inland surface waters monitored for DO, 138 met the required four sampling events as described in Box 1. Applying the methodology for the DO compliance rating, approximately 59 percent or 81 water bodies were considered to have "Good" water quality (Figure 4).

Figure 4. DO Compliance Rating of Monitored Water Bodies, 2006 to 2013.



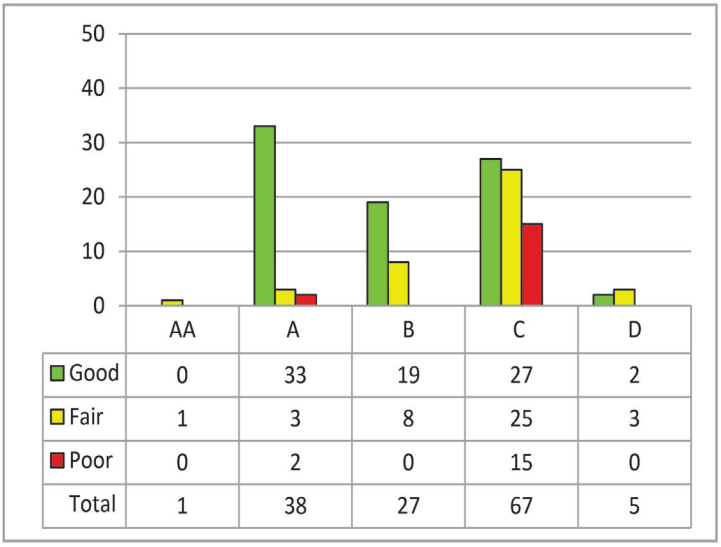
Source: EMB, 2006-2013.

Majority of these waters are Class A or Class C (Figure 5) and are located in CAR, Regions 10, 12, or 13. For Class C waters, a high DO compliance indicates that these water bodies contain ample supply of dissolved oxygen to sustain aquatic life.

Twenty-nine percent recorded "Fair" water quality, while the remaining 12 percent showed "Poor" water quality. As shown in Figure 5, most of these are Class C and are found in Region 3.

Notably, however, the lowest DO compliance ratings were obtained from NCR, with values of less than 12 percent. These are Parañaque River (1.6%), Pasig River (4.4%), Navotas-Malabon-Tullahan-Tinejeros River (NMTT) (7.2%), and San Juan River (11.5%).

Figure 5. DO Compliance Rating per Water Body Classification.



	AA	A	B	C	D
Good	0	33	19	27	2
Fair	1	3	8	25	3
Poor	0	2	0	15	0
Total	1	38	27	67	5

Source: EMB, 2006-2013.

Other water bodies which were considered to have "Poor" water quality in terms of DO are:

- Meycauayan River (1.3%) – Region 3
- Calapan River (6.7%) – Region 4B
- Guadalupe River (Lower Reach) (10.6%) – Region 7

Low DO levels in these water bodies can be attributed to the discharge of wastewater coming from runoffs and nearby communities and establishments.

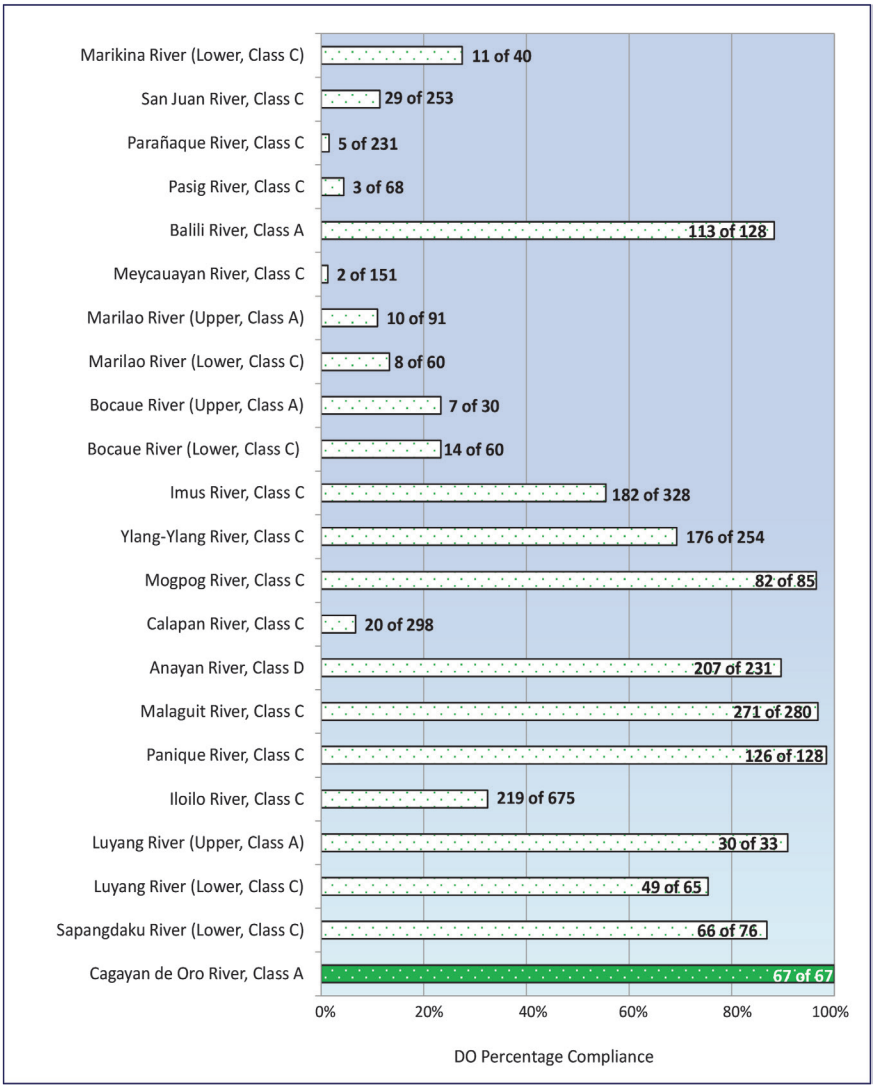
Table 5. Priority Rivers under the *Sagip Ilog* Program.

Region	Water Body	Classification*
NCR	Marikina River (Lower)	C
	San Juan River	C
	Parañaque River	C
	Pasig River	C
CAR	Balili River	A
3	Meycauayan River	C
	Marilao River (Upper)	A
	Marilao River (Lower)	C
	Bocaue River (Upper)	A
	Bocaue River (Lower)	C
4A	Imus River	C
	Ylang-Ylang River	C
4B	Mogpog River	C
	Calapan River	C
5	Anayan River	D
	Malaguit River	C
	Panique River	C
6	Iloilo River	C
7	Luyang River (Upper)	A
	Luyang River (Lower)	C
	Sapangdaku River (Lower)	C
10	Cagayan de Oro River	A

Note: * - Refers to the designated beneficial use of a water body (not necessarily indicating its current water quality)

Source: EMB, 2006-2013.

Figure 6. DO Percentage Compliance Rating of the Priority Rivers, 2006 to 2013.



Source: EMB, 2006-2013.

Under the *Sagip Ilog* Program, EMB selected 19 priority rivers for monitoring. These rivers, along with their regional locations and classifications, are presented in Table 5. DO percentage compliance ratings of these rivers from 2006 to 2013 are summarized in Figure 6. In general, the figure presents the number of sampling events that passed the water quality criterion out of the total number conducted.

Of the 19 priority rivers monitored for DO, only Cagayan de Oro exhibited 100 percent compliance. Also notable are Panique, Malaguit, and Mogpog Rivers, and the Upper Reach of Luyang River for achieving more than 90 percent compliance ratings as they failed to meet their respective criterion in only one to nine sampling events.

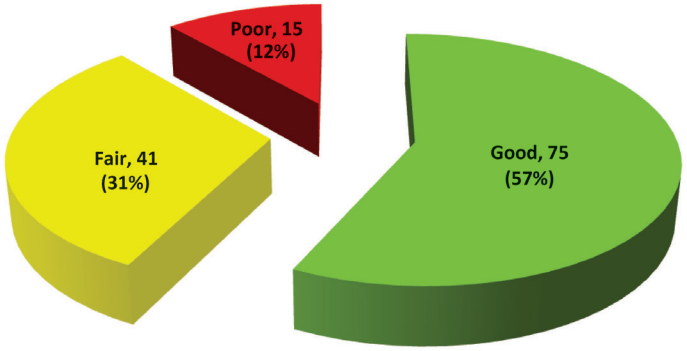
On the other hand, Balili, Anayan, and Sapangdaku Rivers, and the Lower Reach of Luyang River achieved 75 to 90 percent compliance ratings as they failed to meet their respective criterion in at most 24 sampling events. In addition, Imus River met its criterion in 182 of its 328 sampling events, resulting in a compliance rating of 55 percent.

Unfortunately, the remaining rivers, all of which are located in metropolitan areas in Luzon, exhibited compliance ratings of less than 35 percent. Of these, Pasig, Parañaque, and Meycauayan Rivers exhibited the lowest compliance ratings of less than two percent.

3.1.2 BOD

BOD determines the concentration of oxygen required for the decomposition of organic matter from a pollution source. The demand for oxygen does not occur directly where the effluent or runoff water is discharged. Instead, it is manifested downstream where the decomposition finally occurs. Thus, a higher BOD value indicates a greater degree of pollution. Most aquatic organisms cannot survive if the BOD level is above 7 mg/L.

Figure 7. BOD Compliance Rating of Monitored Water Bodies, 2006 to 2013.

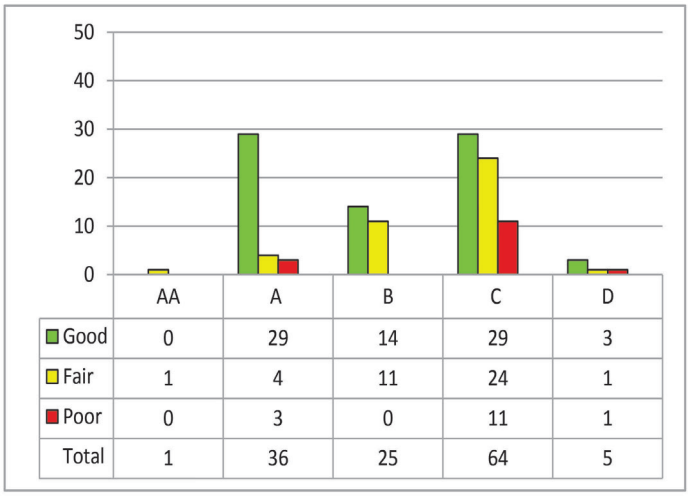


Source: EMB, 2006-2013.

Of the 131 inland surface waters that met the requirements in Box 1, results showed that the water quality of approximately 57 percent or 75 water bodies (Figure 7) are considered "Good" in terms of BOD compliance. Similar to the DO monitoring results, most of these water bodies are classified as Class A or Class C (Figure 8) and are also concentrated in CAR, Regions 10, 12, or 13.

About 31 percent showed "Fair" water quality, while the remaining 12 percent exhibited "Poor" water quality. Furthermore, two water bodies, both of which are located in NCR, did not meet the criterion in all sampling events. These are Parañaque and San Juan Rivers.

Figure 8. BOD Compliance Rating per Water Body Classification.

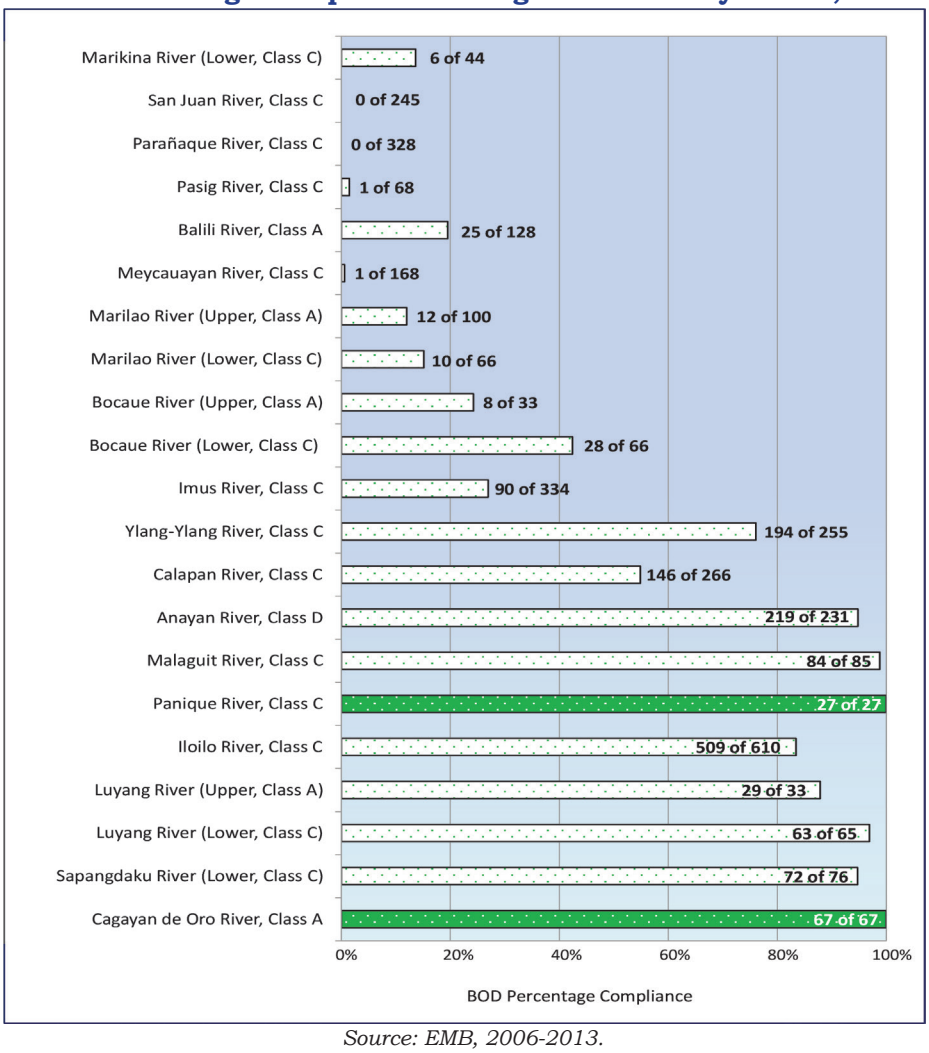


	AA	A	B	C	D
Good	0	29	14	29	3
Fair	1	4	11	24	1
Poor	0	3	0	11	1
Total	1	36	25	64	5

Source: EMB, 2006-2013.

Figure 9 presents the BOD percentage compliance ratings of the priority rivers from 2006 to 2013. Similar to its remarkable DO monitoring results, the BOD levels of Cagayan de Oro River consistently met its criterion. Panique River also exhibited a 100 percent compliance to the BOD criterion.

Figure 9. BOD Percentage Compliance Rating of the Priority Rivers, 2006 to 2013.



Source: EMB, 2006-2013.

Anayan and Sapangdaku Rivers and both reaches of Luyang River displayed minimal deviations to their respective criterion. Hence, these rivers achieved relatively high compliance ratings of more than 85 percent. Notably, Malaguit River did not meet its criterion in only one sampling event out of the 85 conducted, thus displaying a high compliance rating of 99 percent.

On the other hand, Iloilo, Ylang-Ylang, and Calapan Rivers displayed deviations in more than 100 sampling events out of the total number conducted; and achieved BOD compliance ratings of 83 percent, 76 percent, and 55 percent, respectively. The remaining rivers exhibited BOD compliance ratings of less than 50 percent. As underscored in Figure 9, Pasig and Meycauayan Rivers met their respective criterion in only one sampling event. Even more alarming is that of San Juan and Parañaque Rivers, which consistently failed in all 245 and 328 sampling events, respectively.

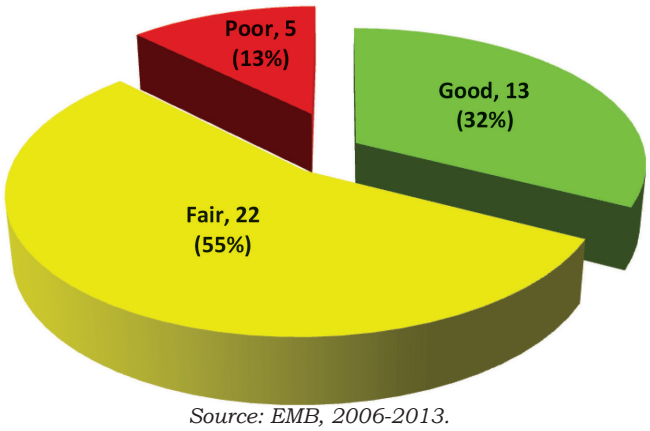
3.1.3 TSS

TSS measures the concentration of undissolved solid particles in water, such as silt, decaying plant and animal matter, and domestic and industrial wastes. It is indicative of the extent of sedimentation resulting from land-based activities. The higher the TSS value, the lower is the ability of the water to support aquatic life due to reduced light penetration. This impacts photosynthesis in aquatic plants, clogs fish gills, and increases absorption of heat that results in higher water temperatures, among others.

According to DAO 1990-34, the TSS level in water bodies used as sources of water supply should not exceed 25 mg/L for Class AA waters and 50 mg/L for Class A waters. Among the inland surface waters monitored for TSS, only 40 Class AA and Class A water bodies met the requirements specified in Box 1. These consist of 17 principal rivers, 21 minor rivers, and two lakes (Lake Ambulalakaw in CAR and Lake Mainit in Region 13).

As illustrated in Figure 10, about 32 percent or 13 water bodies exhibited "Good" water quality, with only two not achieving 100 percent compliance rating. These are the upper section of Taguibo River and Lake Mainit with 99 percent and 98 percent compliance rating, respectively.

Figure 10. TSS Compliance Rating of Monitored Water Bodies, 2006 to 2013.

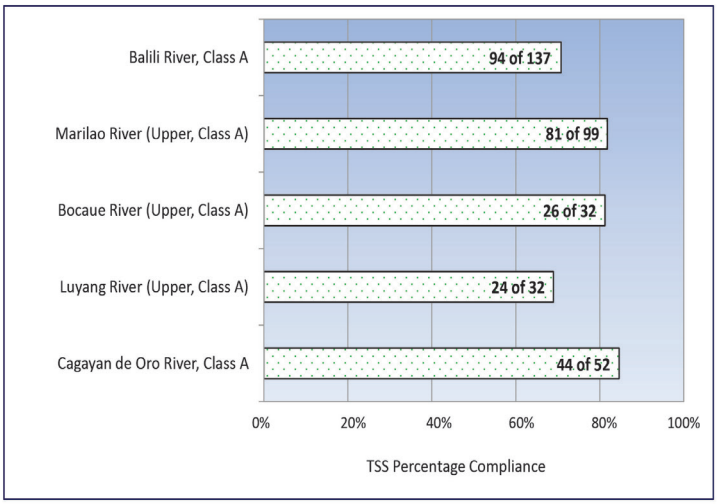


Source: EMB, 2006-2013.

Approximately 55 percent or 22 water bodies were considered to have "Fair" water quality, the majority of which are located in CAR or Region 12. Lastly, five water bodies comprised the remaining 13 percent that showed "Poor" water quality. These are Panay River (Upper Reach) in Region 6, Guindarohan River (Upper Reach) in Region 7, Davao River (Upper Reach) in Region 11, Lun Masla River in Region 12, and Iponan River in Region 10, the last of which did not meet the prescribed criterion in all sampling events.

Among the 19 priority rivers, only five are classified as Class A and were monitored for TSS. As shown in Figure 11, all five rivers exhibited fair compliance ratings to the TSS criterion. Cagayan de Oro River consistently showed the highest compliance rating with 85 percent, while Marilao and Bocaue Rivers followed with 82 percent and 81 percent, respectively. On the other hand, Balili River and the Upper Reach of Luyang River displayed compliance ratings of 69 percent and 70 percent, respectively.

Figure 11. TSS Percentage Compliance Rating of the Priority Rivers, 2006 to 2013.



Source: EMB, 2006-2013.

3.1.4 Phosphates

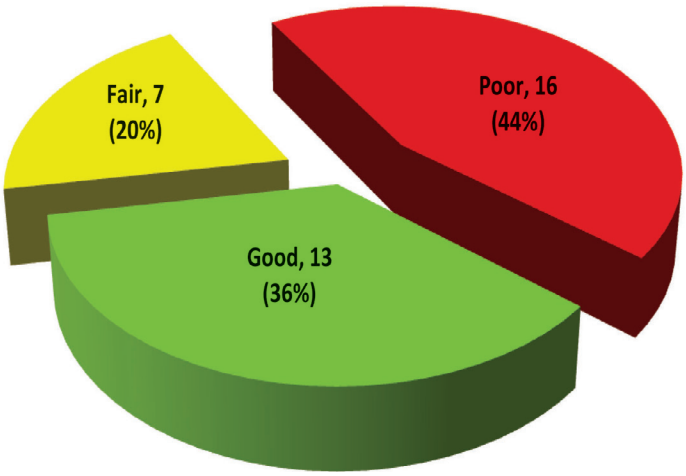
Phosphates occur either as particulate phosphates or dissolved phosphates. Particulate phosphates include phosphates absorbed by soil particles and organic matter eroded during runoff from cultivated lands, and provide a long-term source of phosphates for aquatic biota. On the other hand, dissolved phosphates include runoff from grass or forest land, which carries little sediment, and is available for biological uptake.

Phosphates are usually found in detergents, raw sewage, and nutrient fertilizers for plants. The presence of excess phosphates can cause enormous algal bloom, a form of cyanobacteria, which can produce neurotoxins (affecting the nervous system) and hepatoxins (affecting the liver). Once a vast mass of excess algae die and decompose by oxidation, the water is depleted of dissolved oxygen and may result to fish kill.

Among the inland surface water bodies, 41 (consisting of 53 water body classifications) were monitored for their phosphate content. Of these, only 31 water bodies (36 classifications) met the requirement of four sampling events as described in Box 1.

Unfortunately, results (Figure 12) showed that 44 percent had "Poor" water quality, and these water bodies mostly consisted of Class C waters in Region 3. On the other hand, 36 percent exhibited "Good" water quality, while 20 percent showed "Fair" water quality. High phosphate levels could be attributed to sewage discharge as well as agricultural activities, where phosphate-containing fertilizers are used.

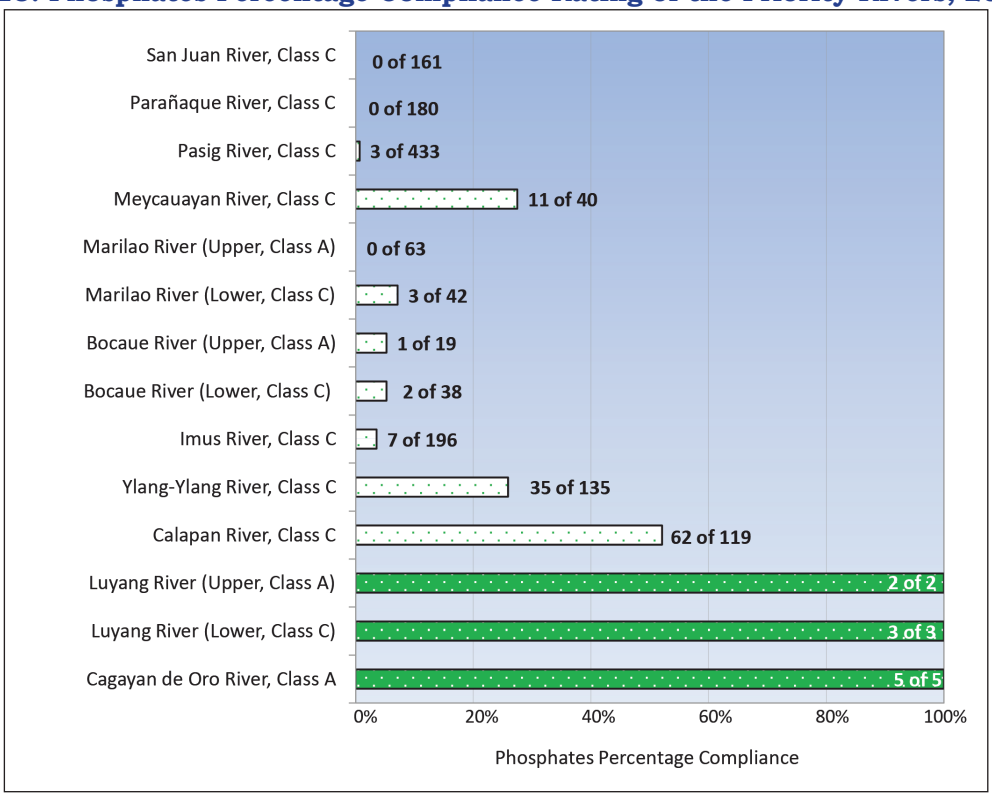
Figure 12. Phosphates Compliance Rating of Monitored Water Bodies, 2006 to 2013.



Source: EMB, 2006-2013.

As presented in Figure 13, Cagayan de Oro River and both reaches of Luyang River met the phosphate criteria 100 percent of the time, although a maximum of only five sampling periods was conducted for these two rivers. For the other priority rivers, compliance ratings to the phosphate criteria was notably low. The highest compliance rating was that of Calapan River at 52 percent, followed by Meycauayan and Ylang-Ylang River at 28 percent and 26 percent, respectively. Bocaue, Imus, Marilao (Lower Reach), and Pasig Rivers exhibited even lower compliance ratings at less than eight percent. Even more alarming is that of Parañaque, Marilao (Upper Reach), and San Juan Rivers, which consistently failed their respective phosphate criterion.

Figure 13. Phosphates Percentage Compliance Rating of the Priority Rivers, 2006 to 2013.



Source: EMB, 2006-2013.

3.1.5 Nitrates

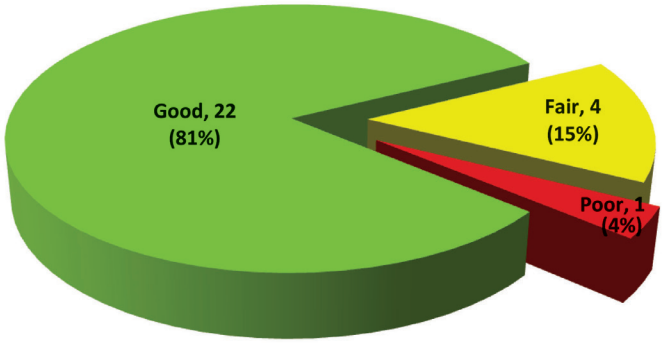
Nitrates in the environment consist of salts of ammonium, sodium, potassium, and calcium. Similar to phosphates, nitrates in water bodies come from soil fertilizers during agricultural runoff as well as from sewage discharge and septic systems where they are formed as by-products of the decomposition of animal or human wastes. Consequently, high nitrate concentrations can inhibit the growth of fish, impair the immune system, and cause stress in some aquatic species.

Of the 36 waters monitored for nitrates, a total of 27 Class A and Class C surface waters met the requirements of Box 1 (Figure 14). Of these, 22 (81%) recorded "Good" water quality and are concentrated in Region 3.

On the other hand, the water quality of four water bodies was found to be "Fair"; while only one (4%) water body, San Juan River, showed "Poor" water quality.

Low nitrate content in water bodies are beneficial for Class C waters as these are intended for the propagation and growth of fish and other aquatic species.

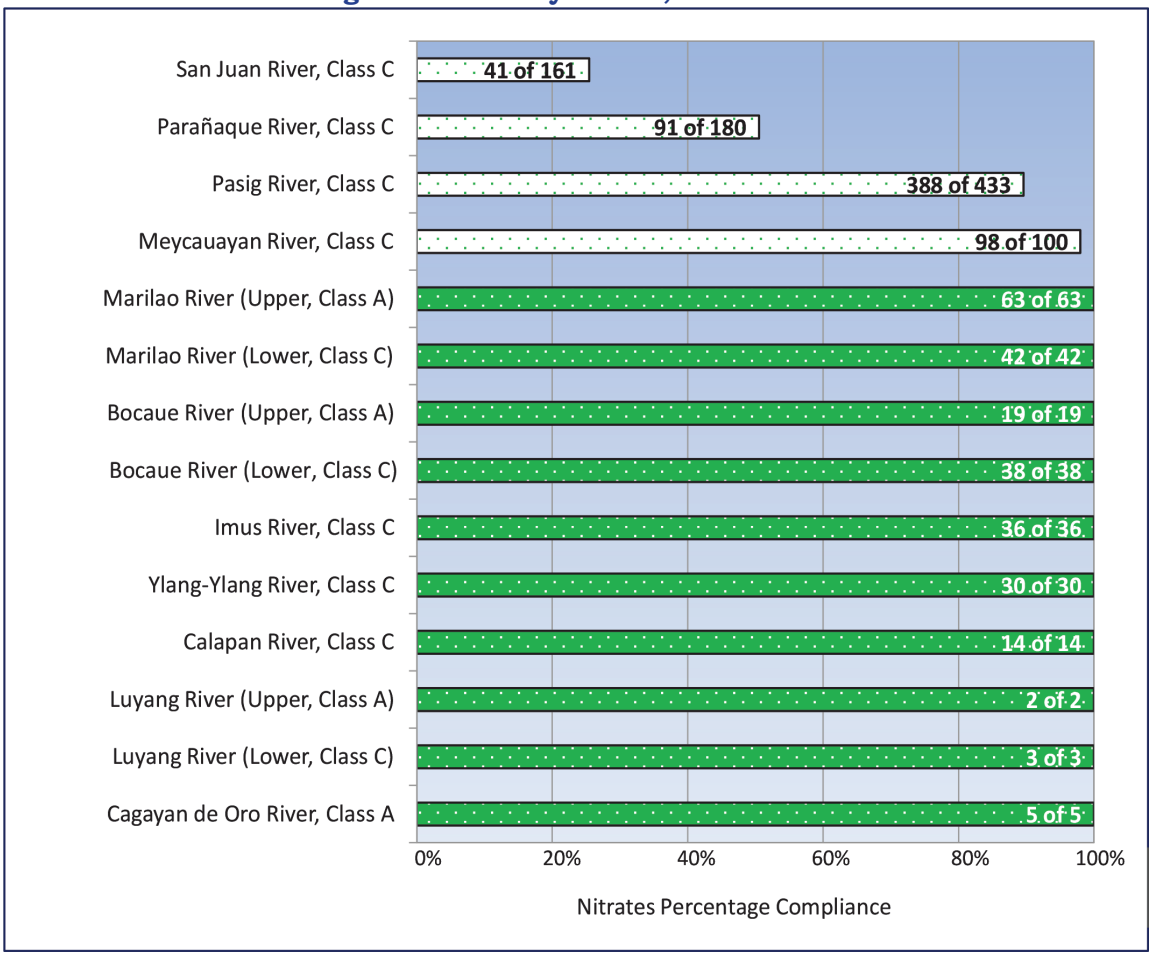
Figure 14. Nitrates Compliance Rating of Monitored Water Bodies, 2006 to 2013.



Source: EMB, 2006-2013.

Figure 15 presents the percentage compliance rating of the priority rivers monitored for nitrate levels from 2006 to 2013. Of these, only four rivers did not exhibit 100 percent compliance. Meycauayan River achieved 98 percent compliance rating out of the 100 sampling events; while Pasig River displayed 90 percent compliance rating, meeting its criterion in 388 of 433 sampling events. On the other hand, Parañaque and San Juan Rivers showed the lowest compliance ratings at 51 percent and 26 percent, respectively.

Figure 15. Nitrates Percentage Compliance Rating of the Priority Rivers, 2006 to 2013.



Source: EMB, 2006-2013.

3.1.6 Heavy Metals

Heavy metals in ionic form are soluble in water. When discharged into water bodies, they settle in sediments at the bottom of rivers and eventually flow into receiving bays. Once these metals accumulate to concentrations higher than the specified value to maintain healthy waterways, these can become extremely toxic to aquatic life and harmful to people who consume contaminated seafood. As such, heavy metals are monitored in water bodies that are in close proximity to mining, electroplating, tanning, and other similar activities. Specifically, parameters monitored were Total Mercury, Cadmium, and Lead.

Among the inland surface water bodies, 63 were monitored for heavy metals from 2006 to 2013. Of these, only the results for the priority rivers or those with a minimum of three-year data are discussed in this section. These comprise 27 water bodies (32 water body classifications) which are listed in Table 6.

Figure 16 presents the percentage compliance rating of the 16 water bodies (18 classifications) monitored for Total Mercury.

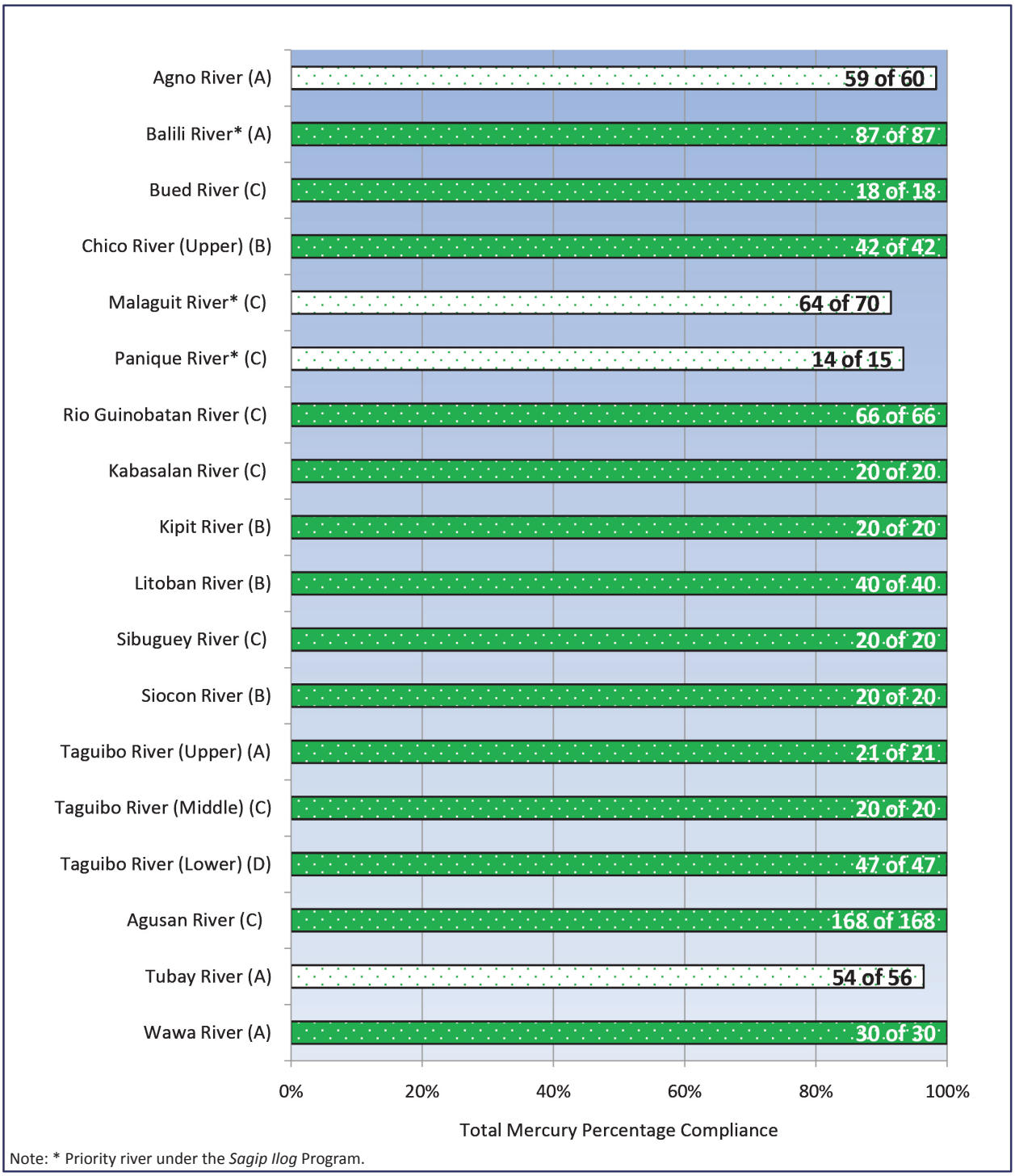
Table 6. List of Water Bodies Monitored for Heavy Metals, 2006 to 2013*.

Region	Water Body	Classification	Monitoring Period	Number of Years Monitored
CAR	Agno River	A	2011-2013	3
	Amburayan River	B	2009-2013	5
	Asin-Galiano River	B	2009-2013	5
	Balili River**	A	2011-2013	3
	Budacao River	B	2010-2013	4
	Bued River	C	2011-2013	3
	Chico River (Upper)	B	2011-2013	3
	Depanay River	B	2010-2013	4
	Pugo River	B	2010-2013	4
3	Meycauayan River**	C	2011	1
	Bocaue River (Upper)**	A	2011	1
	Bocaue River (Lower)**	C	2011	1
	Marilao River (Upper)**	A	2011	1
	Marilao River (Lower)**	C	2011	1
4B	Mogpog River**	C	2011-2013	3
5	Malaguit River**	C	2006-2013	8
	Panique River	C	2006-2011	6
	Rio Guinobatan River	C	2006-2013	8
6	Iloilo River**	C	2012	1
9	Kabasalan River	C	2009-2013	5
	Kipit River	B	2009-2013	5
	Litoban River	B	2009-2013	5
	Sibuguey River	C	2009-2013	5
	Siocon River	B	2009-2013	5
11	Davao River (Upper)	A	2011-2013	3
	Davao River (Lower)	B	2011-2013	3
13	Agusan River	C	2006-2011	6
	Taguibo River (Upper)	A	2007-2009, 2012	4
	Taguibo River (Middle)	C	2007-2009, 2012	4
	Taguibo River (Lower)	D	2007-2009, 2012	4
	Tubay River	A	2008-2010	3
	Wawa River	A	2008-2010	3

Note: * Only water bodies either designated as priority rivers or with three-year data from 2006 to 2013 are presented.
** Priority river under the *Sagip Ilog* Program.

Source: EMB, 2006-2013.

Figure 16. Total Mercury Percentage Compliance Rating of Monitored Water Bodies, 2006 to 2013.



Note: * Priority river under the *Sagip Ilog* Program.

Source: EMB, 2006-2013.

With the exception of Agno, Malaguit, Panique, and Tubay Rivers, all monitored rivers exhibited 100 percent compliance to the maximum limit of 2 micrograms per liter (µg/L). In addition, it was observed that the mercury level in majority of these water bodies remained below 1 µg/L.

In contrast, Agno (98%) and Panique (93%) Rivers both exceeded the criterion in only one sampling event out of the total number conducted, reaching an average concentration of 4.3 µg/L and 430 µg/L, respectively. Likewise, Tubay River (96%) did not meet the criterion in two sampling events out of the 56 conducted, with an average concentration of 2.5 µg/L in both instances. Moreover, Malaguit River (91%) failed to meet the criterion in six out of the 70 sampling events conducted, with average concentrations from as low as 3 µg/L to as high as 9 µg/L.

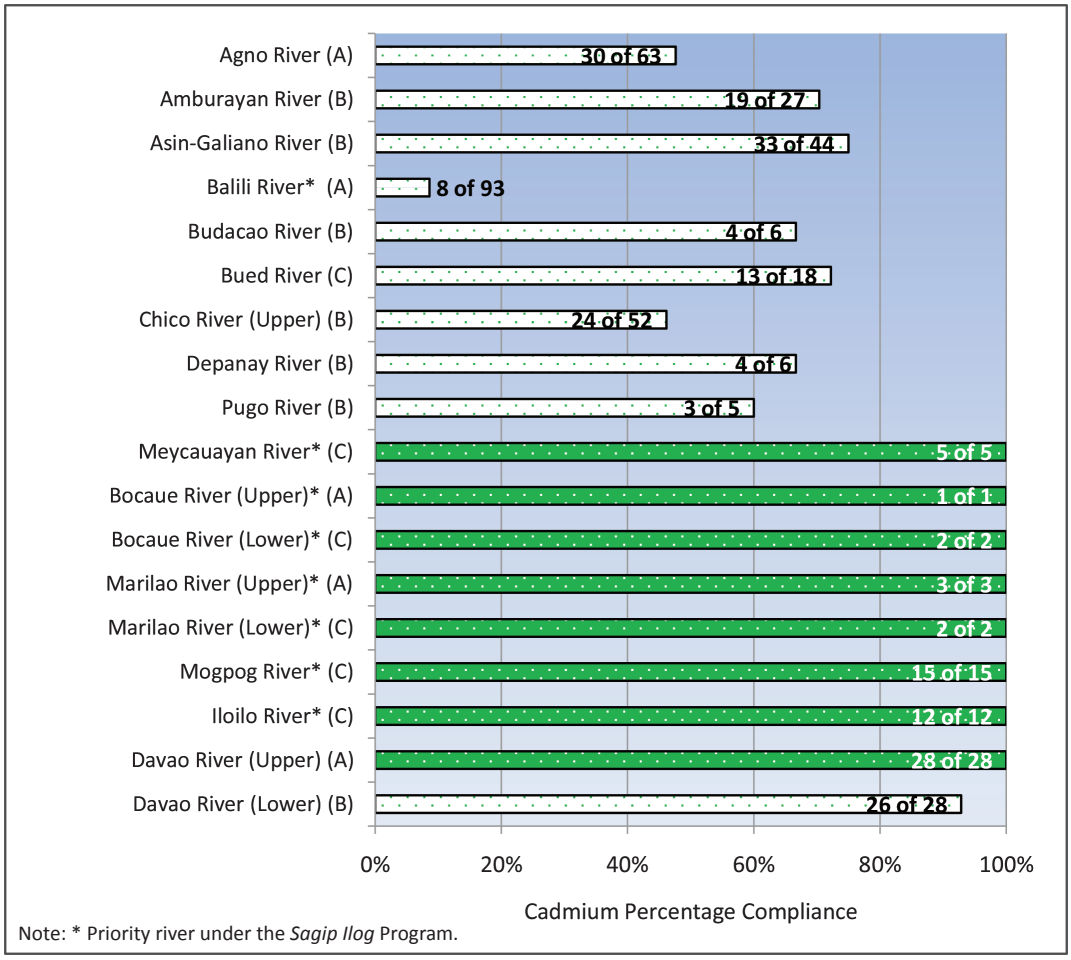
The presence of excess mercury in these Class A water bodies could be detrimental to their use as a source of potable water.

In terms of Cadmium, Figure 17 shows that eight out of the 18 water body classifications monitored met the maximum limit of 0.01 mg/L throughout the entire monitoring period. It is worth noting, however, that the percentage compliances of five surface waters were derived from a small number of sampling events, ranging from one to five. These are Meycauayan River as well as both reaches of Bocaue and Marilao Rivers. As such, frequent monitoring of these surface waters must be conducted to ensure that the results are representative of the rivers' water quality throughout the monitoring period, and that these remain at acceptable levels.

On the other hand, 10 surface waters showed deviations to the criterion. These exceedances ranged from as low as 0.011 mg/L to as high as 0.108 mg/L, with a median value of 0.014 mg/L. Of these, the Class B section of Davao River exhibited the highest compliance rating with 93 percent. This is followed by Asin-Galiano, Budacao, and Amburayan Rivers with compliance ratings above 70 percent.

Ironically, the Class A rivers, Chico, Balili, and Agno Rivers, had lowest compliance ratings. Balili River, which is a priority river, showed only nine percent compliance to the criterion, whereas Agno River and the upper reach of Chico River had compliance ratings of 48 percent and 46 percent, respectively.

Figure 17. Cadmium Percentage Compliance Rating of Monitored Water Bodies, 2006 to 2013.



Note: * Priority river under the *Sagip Ilog* Program.

Source: EMB, 2006-2013.

As for Lead, the percentage compliance of 18 water body classifications monitored are presented in Figure 18. Notably, seven surface waters consistently met the maximum limit of 0.05 mg/L, thus demonstrating a 100 percent compliance rating. However, similar to the results for Cadmium, these were based on a small number of sampling periods.

The remaining 11 surface waters showed exceedances to the criterion. Asin-Galiano River did not meet the criterion in one (0.18 mg/L) out of the 34 samplings conducted, hence receiving the highest compliance rating of 97 percent. This is closely followed by the Lower Reach of Davao River with 96 percent and Mogpog River with 93 percent. On the other hand, Budacao River and the Upper Reach of Davao River met the respective lead criterion with compliance ratings above 80 percent.

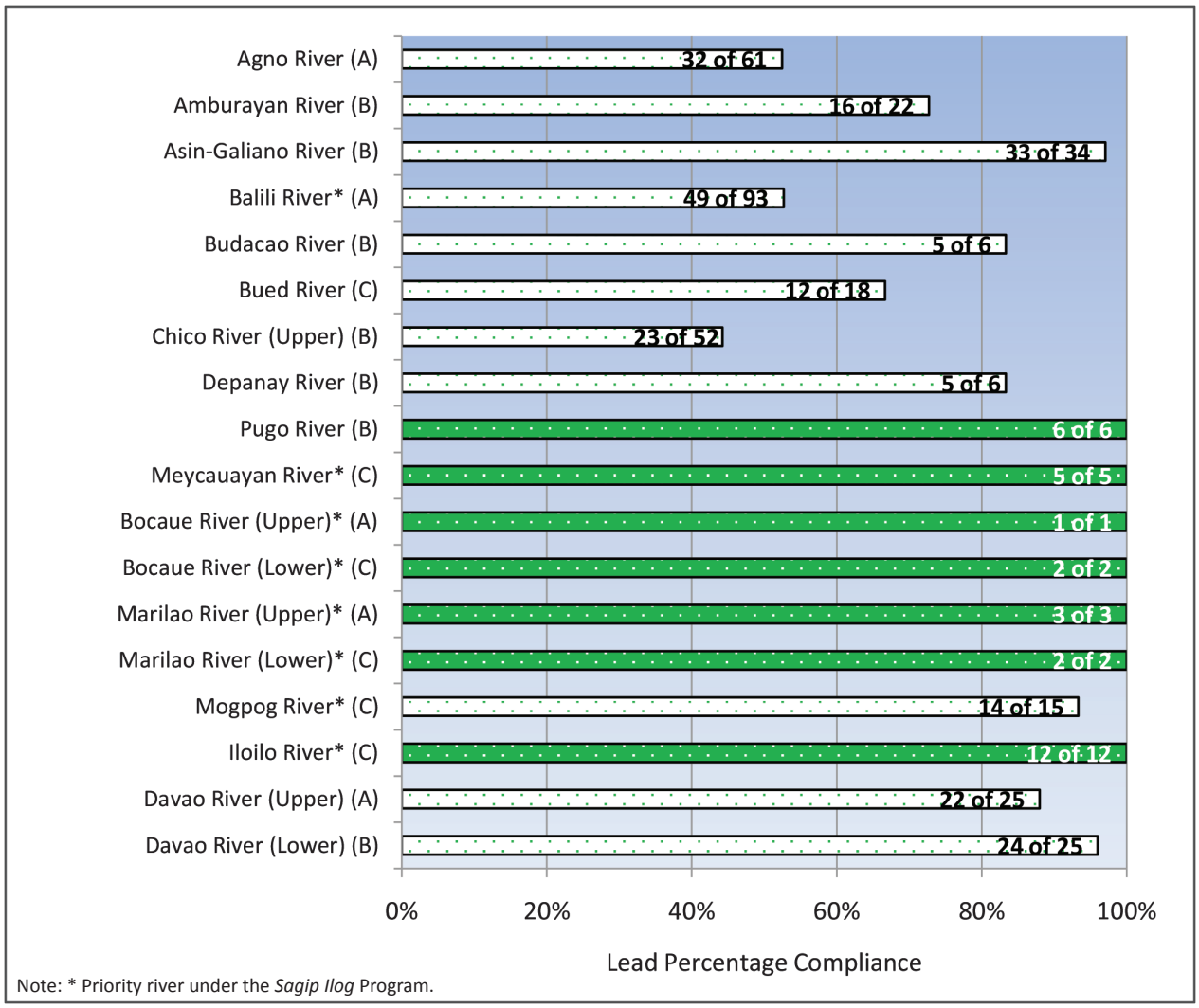
The other five rivers had compliance ratings ranging from 44 percent (Chico River) to 73 percent (Amburayan River). Average Lead concentrations in these water bodies ranged from 0.06 to an alarming level of 0.58 mg/L.

High levels of Mercury, Cadmium, and Lead in water bodies are extremely harmful not only to the environment, but also to nearby communities that rely on these water bodies for their daily activities. These toxic metals can easily enter the body either through ingestion or skin contact, where prolonged exposure may result to the following symptoms:

- Nausea/vomiting
- Diarrhea
- Kidney and liver failure
- Cognitive and neuromuscular dysfunction
- Death

Source: World Health Organization (WHO)

Figure 18. Lead Percentage Compliance Rating of Monitored Water Bodies, 2006 to 2013.



Note: * Priority river under the *Sagip Ilog* Program.

Source: EMB, 2006-2013.

3.1.7 Cyanide

Cyanide (as Free Cyanide) refers to cyanide and cyanic compounds such as hydrogen cyanide and the metallic forms of sodium and potassium cyanide. These may enter water bodies through storm runoff, leaching, and other means of waste discharge, including those from mine tailings. When present in water, cyanide does not bio-accumulate in aquatic species. However, high concentrations can still be toxic to aquatic life and to the people who consume aquatic food sources.

From 2006 to 2013, 11 inland surface water bodies were monitored for their cyanide content (as free cyanide), eight of which were monitored for a minimum of two years. These are listed in Table 7, while the results are summarized in Figure 19.

Results showed that Matiao, Hijo, Kingking, and Agusan Rivers consistently met the maximum limit of 0.05 mg/L during the respective monitoring period, with an annual concentration of less than 0.03 mg/L.

On the other hand, the remaining four rivers showed deviations to the criterion. Of these, Rio Guinobatan River demonstrated the highest compliance rating with 96 percent, followed by Naboc River with 88 percent. Cyanide levels in these two rivers have peaked at 0.27 mg/L and 0.72 mg/L, respectively.

Furthermore, Panique River exhibited a 73-percent compliance to the criterion, with a maximum concentration of 0.39 mg/L. Lastly, Malaguit River had the lowest compliance rating of 59 percent, as well as the highest recorded cyanide level of 1.12 mg/L.

Based on the results, water bodies with exceedances to the criterion must be monitored more frequently to closely observe and determine the source of high levels of cyanide. Moreover, rehabilitation and control measures must be established to improve the quality of these waters as well as mitigate their ill-effects to nearby communities.

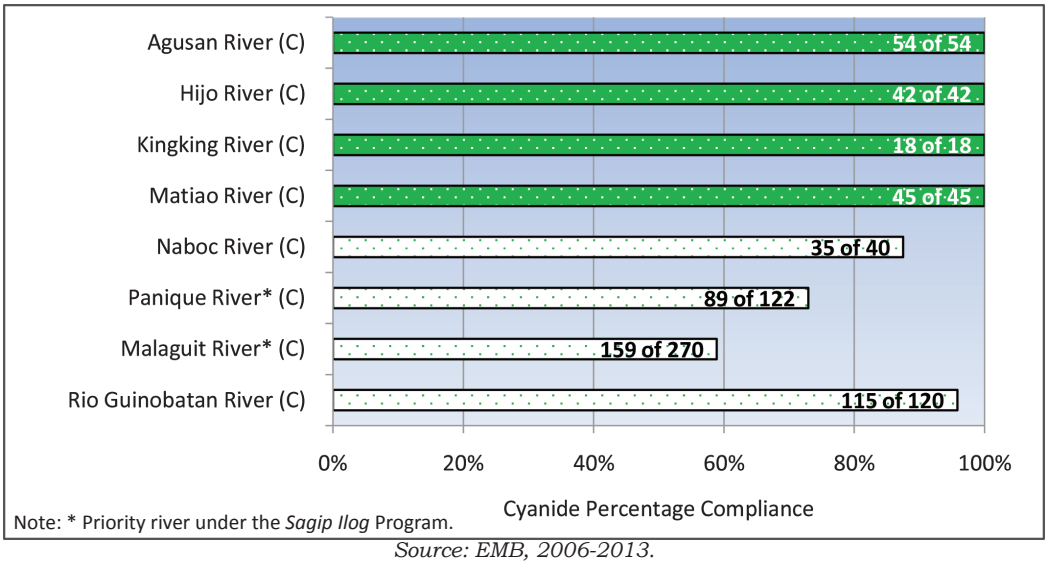
Table 7. List of Water Bodies Monitored for Cyanide, 2006 to 2013*.

Region	Water Body	Classification	Monitoring Period	No. of Years Monitored
5	Rio Guinobatan River	C	2006, 2008, 2011-2013	5
	Malaguit River**	C	2006-2013	8
	Panique River	C	2006-2011	6
11	Naboc River	C	2012-2013	2
	Matiao River	C	2012-2013	2
	Kingking River	C	2012-2013	2
	Hijo River	C	2012-2013	2
	Agusan River	C	2012-2013	2

Note: * Only water bodies either designated as priority rivers or with three-year data from 2006 to 2013 are presented.
** Priority river under the *Sagip Ilog* Program.

Source: EMB, 2006-2013.

Figure 19. Cyanide Percentage Compliance Rating of Monitored Water Bodies, 2006 to 2013.



Note: * Priority river under the *Sagip Ilog* Program.

Source: EMB, 2006-2013.

3.2 GROUNDWATER

Groundwater or aquifers refer to water that is collected in porous layers of underground formation. The country's groundwater resources supply the water needs for most households, agricultural activities, and industrial processes, among others. Considering the dependence of most households on groundwater for drinking water, protecting groundwater quality is critical to ensure continuous water supply. Likewise, preventing groundwater contamination is essential considering the difficulties and cost requirements to remediate contaminated groundwater.

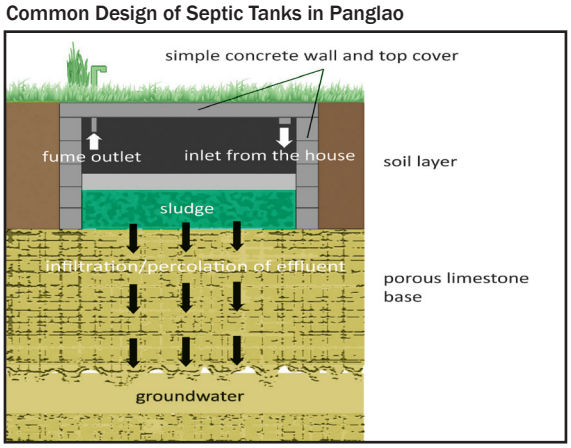
The PNSDW is used for groundwater quality assessment. Relevant parameters to indicate the degree of pollution include Fecal Coliform and nitrates. Though not directly related to pollution, salinity or chloride content is also a common parameter for groundwater quality to indicate the level of contamination from saline water.

3.2.1 Fecal Coliform

Fecal Coliform bacteria are microscopic organisms that indicate significant content of pathogens from feces of warm-blooded animals. They are disease-carrying organisms and have important implications to human health. The PNSDW prescribed that drinking water should contain less than 1.1 Most Probable Number per 100 milliliter (MPN/100mL) using the Multiple Tube Fermentation Technique.

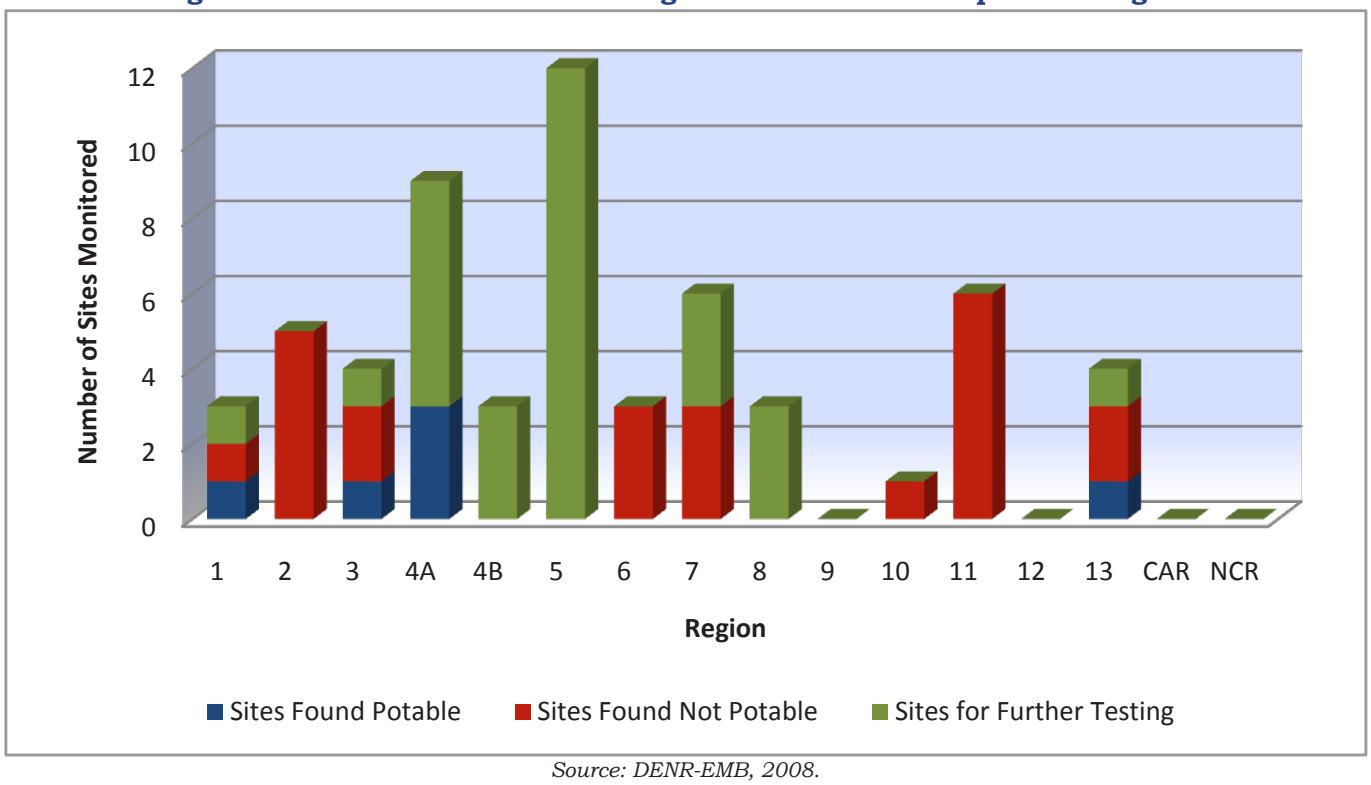
In 2008, EMB implemented the Tapwatch monitoring program, in support of the Department of Health (DOH). Under this program, EMB monitored 59 shallow wells (Figure 20) in selected areas in the country. Of these, six sites were found to contain potable groundwater, while 23 failed to meet the Fecal Coliform standard. The remaining 30 sites required further testing to confirm potability.

A 2011 study (*Tomohiko Kikuchi. Concealed Environmental Threat in the Coastal Region Requires Persistent Attention*) of Panglao Island, Bohol showed high levels of Fecal Coliform bacteria in all the 12 groundwater sampling sites. The contamination was attributable to the design of septic tanks, which lacked waterproof flooring; thereby, allowing the infiltration of waste from the septic tank through the porous limestone base.



Source: Husana and Kikuchi, 2011.

Figure 20. Fecal Coliform Monitoring Results under the Tapwatch Program.



Source: DENR-EMB, 2008.

3.2.2 Nitrates

High levels of nitrate in groundwater are associated with intense agricultural activities, septic systems, confined animal facilities, and wastewater treatment facilities. In drinking water, high levels of nitrate is unhealthy for pregnant women as this could lead to methemoglobinemia or blue baby syndrome due to the decrease in the oxygen-carrying capacity of blood. Moreover, high levels of nitrate can be sensitive to livestock.

Based on a 2007 Greenpeace Report, five out of 18 artesian wells monitored in Benguet and Bulacan showed nitrate levels above the PNSDW limit of 50 mg/L. The highest levels were found in the wells of Buguias, Benguet at 50 percent above the limit. Evidence of pollution with nitrates correlated with intensive farming practices where nitrogen fertilizers were applied in excess.

In 2012, a study (*Nitrates in Drinking Water in the Philippines and Thailand*) assessed the nitrate contamination in groundwater sources in an agro-ecosystem in Laguna. Though all wells tested for nitrates were below the standards, the results showed a correlation between the presence of septic tanks and groundwater use.

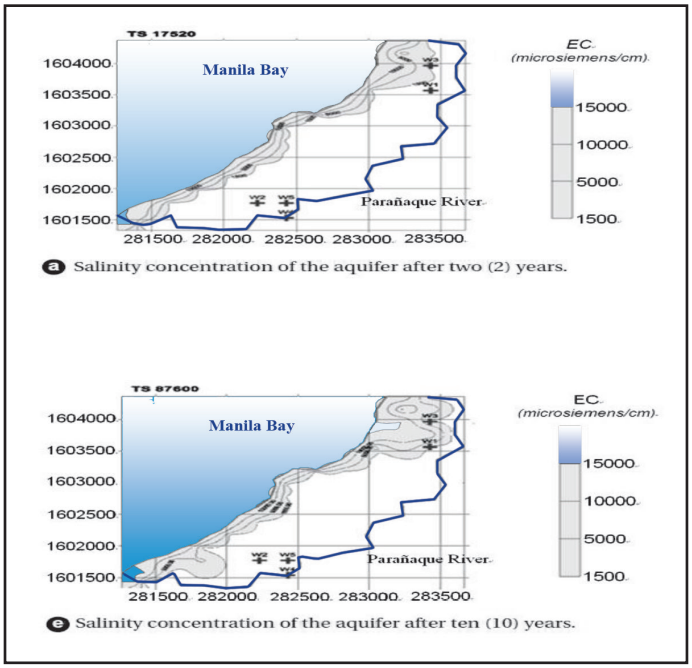
The nitrate concentrations were higher in areas where there are septic tanks, compared to those areas without septic tanks. Well sources used for domestic purposes also showed higher nitrate concentrations over those used for agricultural purposes.

3.2.3 Salinity (Chloride Content)

Groundwater overdraft (over pumping) causes the natural groundwater gradient to reverse and allows seawater to intrude on coastal aquifers. Seawater intrusion can affect drinking water and irrigation wells, and render some areas unsuitable for continued agriculture.

In 2010, a saltwater intrusion model for an aquifer bounded by Manila Bay and Parañaque River was generated using the 3D finite element method. The model showed that after 10 years, the aquifer will be subjected to severe saltwater intrusion from the Manila Bay. The salinity may come to cover the whole aquifer due to the continual slow penetration of saltwater into the aquifer.

Saltwater Intrusion Model



Source: Insigne and Kim, 2010.

Box 2. Assessment of Groundwater Vulnerability to Contamination in Boracay Island.

In 2013, a study was conducted to assess the vulnerability of the groundwater in Boracay Island, Aklan to contamination using the DRASTIC model in combination with Quantum Geographic Information System (GIS). Results confirmed the high vulnerability of Boracay Island's groundwater resources to contamination and that unregulated pressures due to tourism development could lead to the further degradation of the groundwater and coastal water resources.

In terms of spatial extent, approximately 4.10 sq km of Boracay Island are moderately vulnerable, 5.62 sq km are highly vulnerable, and 0.30 sq km are very highly vulnerable to groundwater contamination.

Source: Linan, Ella, and Florece, 2013.

3.3 COASTAL AND MARINE WATERS

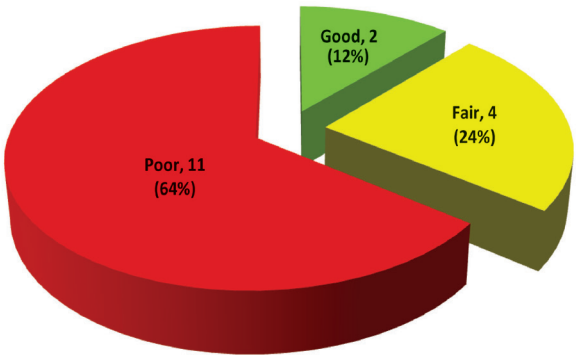
From 2006 to 2013, EMB monitored 21 coastal and marine waters, eight of which have two classifications. These add up to a total of 29 monitored classifications. Eleven of these are Class SC, while one is Class SA. In addition, 17 Class SB waters were monitored largely as part of EMB's Beach Watch Program.

3.3.1 Fecal Coliform

Fecal Coliform level is especially significant for Class SB water bodies as activities in these waters involve high human interface (e.g., bathing, swimming, and diving); hence, exposing humans to the threat of diseases caused by bacteria.

Of the 17 Class SB water bodies that met the minimum requirement of four sampling events as described in Box 1, only two had "Good" water quality, namely: Puerto Princesa Bay in Region 4B and Boracay Coastline in Region 6. On the other hand, four were of "Fair" water quality, while the remaining 11 showed "Poor" water quality (Figure 21).

Figure 21. Fecal Coliform Compliance Rating of Monitored Water Bodies, 2006 to 2013.



Source: EMB, 2006-2013.

Four water bodies failed to meet the Class SB criterion of 200 MPN/100 mL in all sampling events. These water bodies are:

- Manila Bay – NCR, Region 3, and Region 4A
- Nasugbu Bay – Region 4A
- Coron Bay – Region 4B
- Iloilo City Coastline (Region 6)

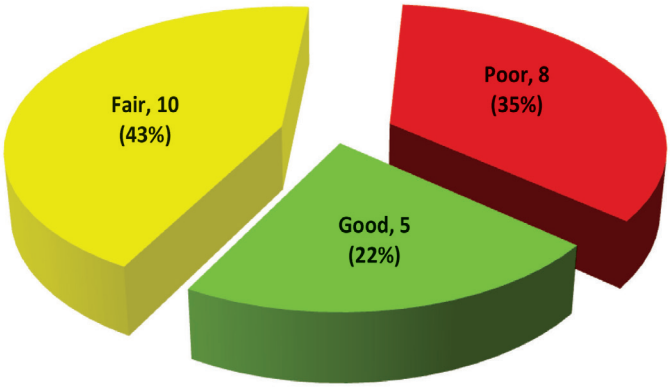
As such, the surrounding areas of these waters must be evaluated to determine the source of the high levels of Fecal Coliform bacteria. Consequently, controls, strategies, and measures must be established and implemented to improve the quality of these waters for their intended beneficial use.

3.3.2 Total Coliform

Total Coliform is another essential parameter in evaluating the water quality of coastal waters as this quantifies the total amount of coliform bacteria present, including Fecal Coliform.

Among the 23 coastal and marine water body classifications that met the minimum requirements of Box 1, five exhibited "Good" water quality, 10 recorded "Fair" water quality, and eight displayed "Poor" water quality (Figure 22).

Figure 22. Total Coliform Compliance Rating of Monitored Water Bodies, 2006 to 2013.



Source: EMB, 2006-2013.

Similar to the results for Fecal Coliform, both Puerto Princesa Bay and the Boracay Coastline consistently met the Total Coliform criterion, while Coron Bay exceeded the Total Coliform criterion in all sampling events.

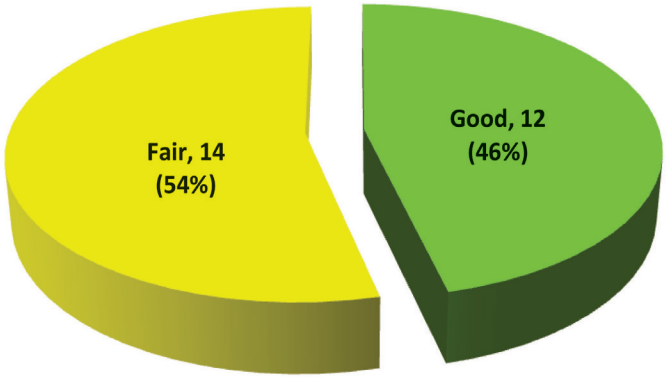
The other three classifications that met their respective Total Coliform criterion in all sampling events are:

- Lingayen Gulf (both classifications) – Region 1
- Guimaras Strait (Class SC) – Region 6

3.3.3 DO

Classes SA, SB, and SC waters all require 5 mg/L of DO as they are used as marine reserves, spawning areas for fishes, and/or wildlife sanctuaries. Of the 26 coastal and marine waters that met the requirements of Box 1, 12 of them exhibited "Good" water quality, while 14 were of "Fair" water quality (Figure 23). No coastal and marine water was rated as "Poor" in terms of DO.

Figure 23. DO Compliance Rating of the Monitored Water Bodies, 2006 to 2013.



Source: EMB, 2006-2013.

Notably, only two out of the 12 water bodies that were rated as "Good" did not display a 100 percent compliance throughout the monitoring period.

These are the Boracay Coastline (Class SB) in Region 6 and Sarangani Bay 2 (Class SC) in Region 12 with compliance ratings of 99 percent and 98 percent, respectively. In contrast, Muelle Bay in Region 4B exhibited the lowest DO compliance with 60 percent.

3.4 POLLUTION LOAD ASSESSMENT

A water body is inadvertently affected when large amounts of foreign materials are in the water ensuing, it to be unfit for its intended beneficial usage. There are two general types of pollution sources: point source and non-point source.

Point source means any identifiable pollution source with a specific discharge point into a particular water body. Examples include commercial and industrial establishments that discharge wastewater or effluent from WWTP or septic tanks. On the other hand, non-point sources have no identifiable source and include rainwater or runoff from irrigation, carrying with it pollutants from farms and urban areas.

3.4.1 Point Sources

Point sources such as human settlements, agricultural sites, as well as commercial and industrial discharges, collectively contribute to the pollution of freshwater, groundwater, and coastal and marine waters. Using BOD as the measure of pollution load (Box 3), it is estimated that 4.5 million metric tons of BOD was generated by pollution point sources in 2013.

Box 3. Computation of Pollution Load Contribution.

Domestic (Municipal) BOD Contribution. Calculated by differentiating the urban and rural population per region for the 2013 population and applying the following BOD factors*:

- Urban – 53 grams BOD per person per day
- Rural – 37 grams per person per day

Agricultural BOD Contribution. Calculated by using animal type and the number of heads of livestock and poultry. Pollution load factors are based on the WHO Rapid Assessment Report.

Industrial BOD Contribution. The annual BOD generation was calculated by multiplying the annual volume of production per industry type by the appropriate pollution load factor in the WHO method.

Non-Point BOD Contribution. Estimated by using the land area for agriculture, forest, and urban uses and multiplying it with the following nitrate factors**:

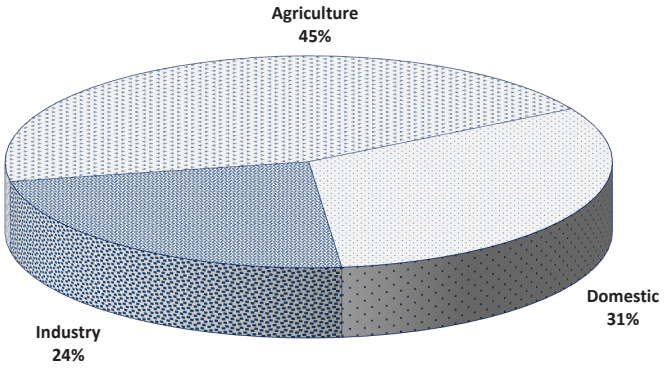
- Urban – 913 kilograms (kg) nitrogen per sq km per year
- Forest – 491 kg nitrogen per sq km per year
- Agriculture – 1,892 kg nitrogen per sq km per year

The computed nitrogen load was converted to BOD load by multiplying it with 1.3 kg BOD per kg nitrogen.

*Sources: *Philippine Environment Monitor, 2003; ** ENRAP Study, 1998.*

Figure 24 presents the estimated pollution load contribution of each point source of pollution. The agriculture sector had the highest contribution, accounting for 45 percent of the total pollution load.

Figure 24. BOD Contribution from Point Sources.

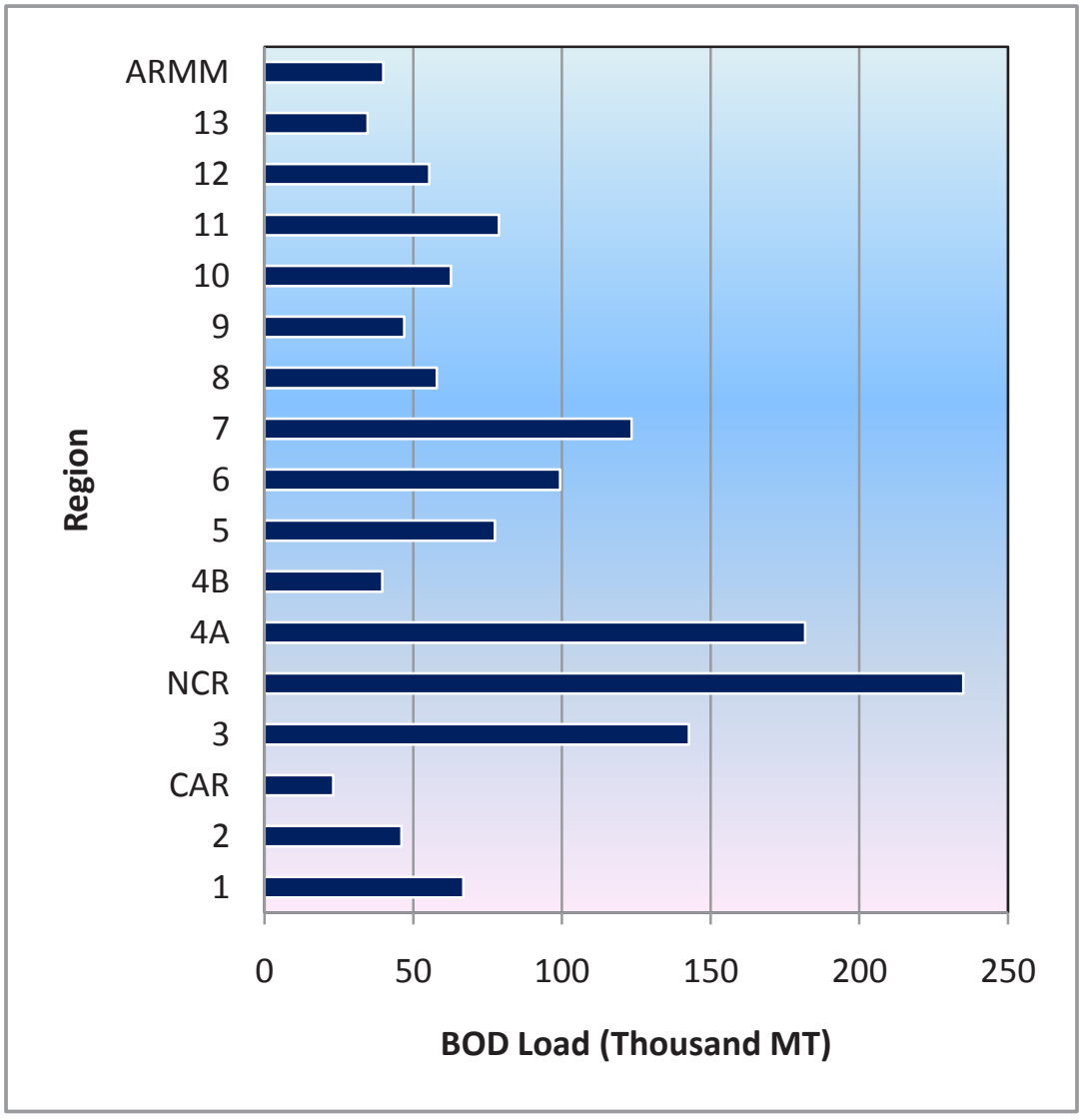


Source: EMB, 2013.

This sector encompasses the production of hogs, chicken, cattle, and other dairy farming activities. Wastewater from this sector is generally high in organic content. Moreover, most of the farms, especially backyard animal farms, have no appropriate wastewater treatment facilities.

The extent of pollution from domestic sources is correlated to the number of people living in an area, as well as to the activities and characteristics of the location (rural or urban). Urban areas will generally contribute to higher BOD because of the quantity of fecal discharges from human and animals, coupled with minimal or lack of sewage treatment facilities. As seen in Figure 25, the densely populated regions of NCR, Region 4A, and Region 3 have the top three BOD load. On the other hand, CAR has the lowest BOD load as it is sparsely inhabited.

Figure 25. Estimated Domestic BOD Contribution per Region, 2013.

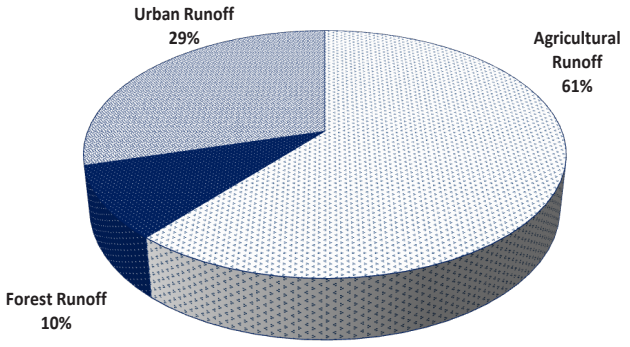


Source: EMB, 2013.

3.4.2 Non-point Sources

Non-point sources are generally the type of pollution load that depends on the land use. Thus, pollution load from non-point sources (Figure 26) are estimated based on land uses – agricultural, forest, and urban. Using the computation method described in Box 3, the BOD loading from non-point sources is estimated to be at 465,595 metric tons. Agricultural runoff contributes 61 percent, followed by urban runoff (29 %) and forest runoff (10%).

Figure 26. BOD Contribution from Non-point Sources.



Source: EMB, 2013.

3.5 PUBLIC HEALTH AND ECOSYSTEM CONCERNS

From 2006 to 2013, several water-related incidents occurred that affected human health and water quality. These are discussed in the ensuing subsections.

3.5.1 Water Supply Contamination

In November 2010, DOH recommended the rehabilitation of Danao City's water source after water sampling results revealed fecal contamination. At least 210 residents were diagnosed with diarrhea, resulting in four deaths. Among them were patients aged between six and 10. However, most of the patients diagnosed with diarrhea were found to be younger than five years old.

It was confirmed that water samples from a spring were contaminated with *Escherichia coli* (*E. coli*) bacteria. *E.coli* bacteria are the most frequent causes of diarrhea and intestinal infections, and their presence in water indicates the presence of fecal waste. The water source was found to be located less than 25 meters from a septic tank.

3.5.2 Fish Kills

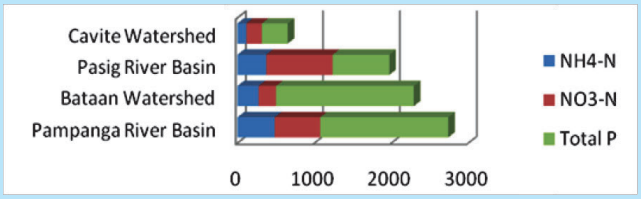
Fish kills can occur as a result of low dissolved oxygen levels in water, abnormal shifts in temperature, deteriorating water quality, or water quality. The following are some of the documented fish kills:

- May 2011 – *Bangus* and *tilapia* production in Taal Lake was largely affected by a fish kill, estimated to have reached 800 metric tons. The fish kill was attributed to climate change, in which the abnormal shift in temperatures led to a sudden drop in the Lake's oxygen level, resulting to massive fish deaths. Later reports have also cited overcrowding of fish cages and overfeeding as other major factors leading to the incident.

Box 4. Assessment of Non-point Source Pollution from Croplands into the Manila Bay.

The watershed approach was used by the Bureau of Soils and Water Management of DA in the assessment of nutrient/ pollution loading from croplands into the Manila Bay system. Comprised of four sub-watersheds, namely, Pampanga River Basin, Bataan watershed, Pasig River Basin (Pasig-Marikina and Pasig-Laguna), and Cavite watershed; croplands comprised 46% of the entire watershed with rice, corn, sugarcane, and coconut as the most extensively cultivated crops. The figure below presents the nutrient loading contribution (in kg/day) of the above mentioned sub-watersheds to Manila Bay. The parameters representative of nutrient loading contribution are:

- Ammonium-Nitrogen (NH_4-N) – Pertains to ammonium expressed in mass of nitrogen
- Nitrate-Nitrogen (NO_3-N) – Pertains to nitrates expressed in mass of nitrogen
- Total Phosphorus – Representative of the mass of all forms of phosphorus (orthophosphate, condensed phosphate, and organic phosphate)



Consistent among all sub-watersheds, the biggest type of nutrient contributed is that of Total Phosphorus, followed by NO_3-N and NH_4-N. Of the four sub-watersheds, Cavite provides the least amount of nutrients to Manila Bay with 651 kg/day. Conversely, Pampanga provides the greatest amount with 2,736 kg/day, about 60% of which is comprised of Total Phosphorus.

- June 2011 – A fish kill hit the waters of Bolinao and Anda in Pangasinan, where at least 10,000 metric tons of *bangus* were affected, amounting to some PhP 3 million worth of losses for the affected fish farms. The Office of the Provincial Agriculturist and the Anda Agriculture Office said that sudden temperature changes due to heavy rains followed by warm days, and oxygen levels dipping below the minimum threshold caused the fish kill.
- May 2012 – A fish kill hit the towns within Rizal and Laguna, and was caused by the deteriorating water quality of Laguna de Bay. This incident was a serious indication of the critical state of the Laguna Lake's ecosystem.

3.5.3 Red Tide Occurrences

Red tide is a natural and seasonal phenomenon identified by the presence of a reddish-brown discoloration of sea water. Harmful algal blooms, in particular, are erratic instances of red tide which can cause damage. These discolorations are the result of high concentrations of single cell micro-organisms, called dinoflagellates; and, under high concentrations, can threaten the health of both marine organisms and humans.

Factors, such as the natural upwelling of water resulting in high nutrient concentrations, together with ideal conditions of temperature, salinity, and light, can trigger the bloom of dinoflagellates and lead to red tides. Moreover, anthropogenic activities, such as the use of fertilizers on farms, waste disposal, coastal development, and the use of fossil fuel, can contribute to or even cause these occurrences.

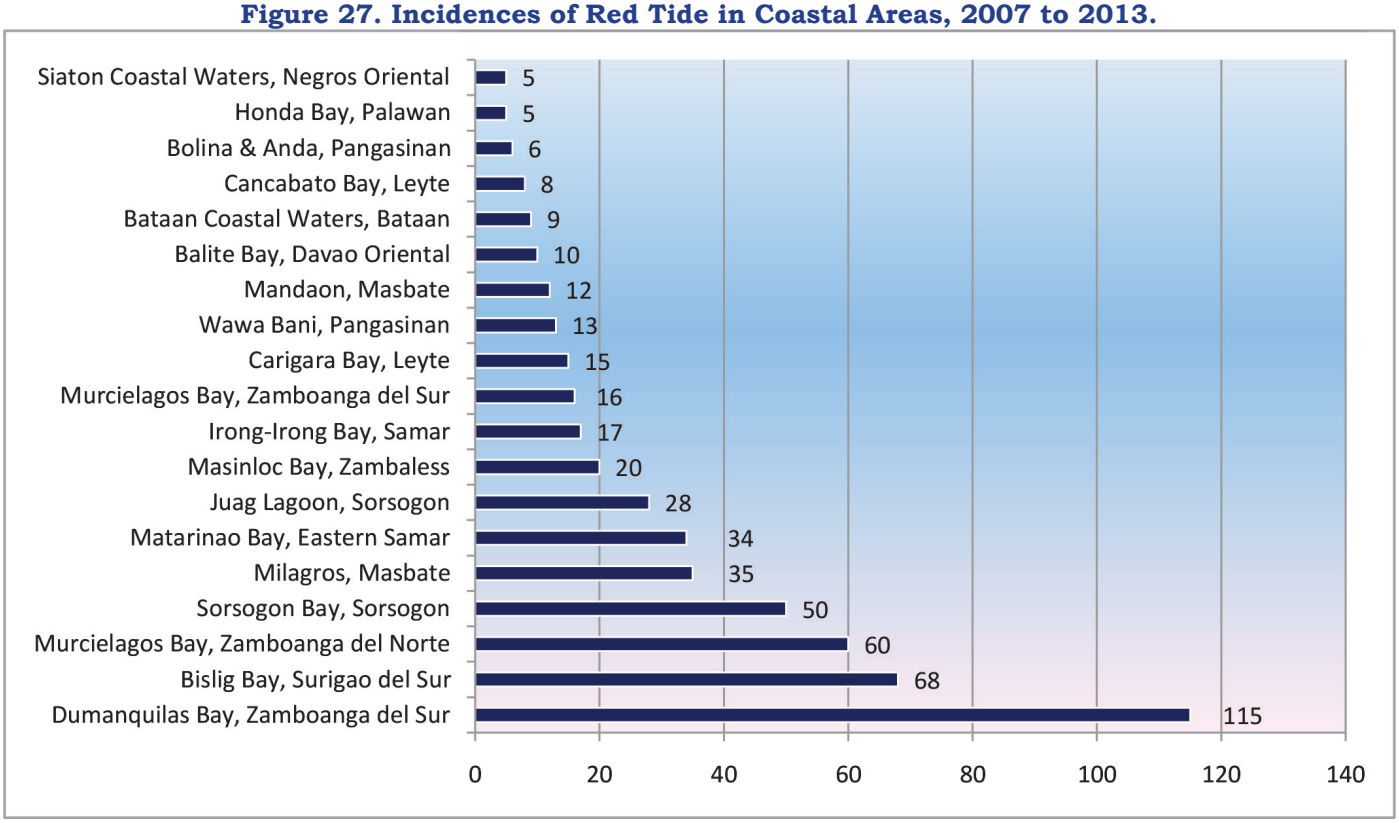
Being an archipelagic country, the Philippines is one of the countries most susceptible to the impacts of red tide. In response to the threat of red tide, the Philippine government, through the Inter-Agency Committee on Environment Health, established the National Red Tide Task Force (NRTTF). Chaired by BFAR and composed of different government agencies and academic institutions, NRTTF implements the *National Red Tide Management Program.*

Under the program, a total of 705 monitoring activities, resulting in the analysis of 6,934 samples, have been conducted to safeguard the public's well-being. Complementary to this, Red Tide Bulletins/Updates have also been prepared and disseminated by the NRTTF in coordination with government agencies and local government units (LGUs).

BFAR's shellfish bulletin, which details the results of the analyses conducted under the program, informs the public of areas affected by red tide. From its first issuance in 5 January 2007 until 10 June 2013, a total of 118 bulletins have been issued. Figure 27 illustrates the frequency of red tide cases in coastal areas from the number of times these are reported through the shellfish bulletin.

Based on Figure 27, the coastal area most susceptible to red tide is Dumanquilas Bay in Zamboanga del Sur. It has been reported as having incidences of red tide in 115 out of the 118 bulletins. However, other areas have significantly lower occurrence rates, with Bislig Bay (Surigao del Sur), Murcielagos Bay (Zamboanga del Norte), and Sorsogon Bay having 68, 60, and 50 incidences, respectively.

Figure 27. Incidences of Red Tide in Coastal Areas, 2007 to 2013.



Source: DA-BFAR, 2013.

Of particular interest is that red tide is most concentrated in the Island of Mindanao, specifically in Zamboanga del Sur and Surigao del Sur. This particular affinity for red tide has been attributed to the northeast monsoon-driven upwelling which happens along the coast of Zamboanga.

3.5.4 Mine Tailing Spillage and Siltation Incidents

On 1 August 2012, a breach of Tailings Storage Facility No. 3 of Philex Mining Corporation (PMC) in Tuba and Itogon, Benguet resulted to the deposition of about 20 million tons of mill tailings (water and sediments) onto Balog Creek – a tributary of the Agno River. This was followed by unprecedented rainfall brought about two successive typhoons.

The Mines and Geosciences Bureau (MGB) issued a cease and desist order (CDO) against PMC the following day and demanded for PhP 1.0344 billion worth of payment and fees for damages caused by the spill. Likewise, on 28 November 2012, a CDO and a fine of PhP 188.6 million was imposed by the Pollution Adjudication Board (PAB) to PMC in violation of RA 9275. PMC paid the government, through MGB, a total of PhP 1.03 billion on 18 February 2013.

3.5.5. Oil and Chemical Spills due to Maritime Disasters

Some of the oil and chemical spill incidents occurring in recent years due to maritime disasters are briefly discussed hereafter.

Guimaras Oil Spill Incident. In August 2006, the M/V Solar I, chartered by Petron (Philippines' largest oil refiner), was carrying 2.4 million liters of oil to the southern island of Mindanao when it went down off Guimaras Island. An estimated 200,000 liters of oil leaked from the tanker, contaminating approximately 24 sq km of area. The oil slick reached the coastal towns of Nueva Valencia and Jordan in Guimaras Island, as well as Villadolid, Pulupandan, and Bago in Negros Island. The spill also headed up through the Guimaras Strait, which is one of the most productive fishing grounds in the country as well as a popular tourist destination. It is home to pristine white sand beaches, several marine sanctuaries, unspoiled coral reefs, and mangrove forests.

The Philippine Coast Guard (PCG) tagged this incident as the worst oil spill in the country's history. According to reports, approximately 10 sq km of mangrove forests were affected, including parts of the Taclong Island Sanctuary (a feeding and breeding ground for fish and other species).

Cordova Oil Spill Incident. In August 2013, the St. Thomas Aquinas, a passenger vessel, collided with a cargo ship near the port of Cebu and took with it 20,000 liters of diesel fuel, 120,000 liters of bunker fuel, and 20,000 liters of lube oil as it went down. The incident left more than 60 people dead and dozens more missing, turning into an environmental catastrophe for the surrounding area as spilled fuel contaminated coastlines. The spill caused problems on three fronts, as it contaminated seashores, the mangroves, and the seabed. The contamination caused a decent amount of profitability loss for Cordova's economy, as local and foreign tourists come to Cordova for its seafood. Aside from being recognized as a prime seafood exporter, the municipality is also home to a number of resort hotels.

Marine Vessel (MV) Princess of the Stars. On 21 June 2008, during the wake of Typhoon Fengshen (local designation Frank), MV Princess of the Stars capsized near the shores of Sibuyan Island. The incident claimed the lives of hundreds of passengers and threatened the surrounding marine waters with contamination from the toxic substances aboard the ship's cargo hold.

Capsized MV Princess of the Stars

Source: www.theguardian.com

The highly toxic substances consisted of five pesticides and were identified as: endosulfan, carbofuran, propineb, metamidophos, and niclosamide. Along with these pesticides, other products and electrical equipment containing environmentally hazardous components such as heavy metals, antifouling compounds in marine paint, and polychlorinated biphenyls (PCBs) in transformers were present in the wreckage.

A team of experts, in collaboration with national authorities, conducted a general evaluation of the environmental and health risks posed by the wreckage. A quarantine zone was established within a 5-km radius from the wreck and a sampling procedure of water and marine organisms was established to determine the presence of contamination. Throughout the duration of the sampling procedure, which started in July 2008; no contamination was reported based on observations and available information.

In September 2008, two salvager firms were contracted to retrieve the cargo containing toxic chemicals within the wreckage. The initial reconnaissance effort revealed that the cargo which contains the toxic substances were still intact. After a few days of salvaging, Transportation Undersecretary Elena Bautista affirmed that an estimated 400 packs of hazardous pesticide endosulfan were retrieved safely from MV Princess of the Stars. By the first week of October 2008, the retrieval of all endosulfan containers from the cargo bay was completed. During the second week of October 2008, all other containers including the equipment that contain toxic substances were recovered. Finally, on the third week of October 2008, approximately 200,000 liters of fuel were removed from the ship's hull.

Cavite Oil Spill Incident. In August 2013, an M/T Makisig tanker was unloading diesel at a Cavite terminal of Petron Corporation when a leak from an underwater pipe connected to the vessel caused a large oil spill to spread throughout the waters of Manila Bay.

Aerial surveys of the incident revealed an estimated 500,000 liters (132,000 gallons) of diesel fuel leaked from the submerged pipeline, spreading over a 300-sq km area and covering 20 km of shorelines with red slick. The spill affected four coastal towns in Cavite, namely: Rosario (a major fish port town), Ternate, Naic, and Tanza, and even threatened to reach the Island of Corregidor. Consequently, all fishing activities along the contaminated coastlines were suspended, forcing residents, some of them fishermen, to collect the diesel fuel in barrels for sale or in exchange for rice and canned meat.

The PCG and Cavite government officials filed charges against Petron, calling the oil spill a repeat of a July 2010 incident, when diesel fuel also leaked from the submerged pipelines of the Petron oil depot and adversely affected the fisherfolk families of the same Cavite towns. Petron issued an apology to the affected communities and mobilized clean-up operations, disbursement of compensation, medical missions, distribution of food items, and other forms of assistance under the guidance of PCG and local governments. A week following the incident, only one to two percent of the leaked diesel remained with minimal oil sheen. By the second week, water samples have passed the oil/grease and oxygen standards, and BFAR has declared the marine life in Cavite safe for consumption.

3.6 SEWERAGE AND SANITATION

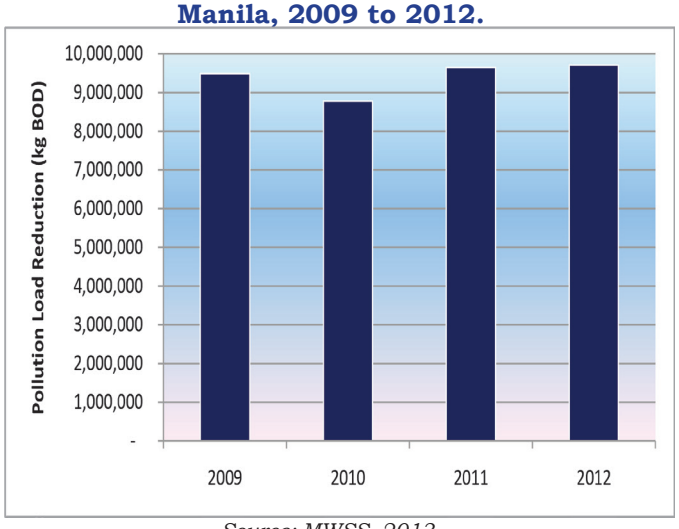
It is reported that 76.8 percent of families in the Philippines have sanitary toilet facilities (DOH, 2008). As documented in 2010 in the National Sewerage and Septage Management Program (NSSMP), less than 10 percent have access to piped sewerage systems. Those that are not connected to a sewerage network rely on septic tanks, pit latrines, or practice open defecation. The lack of proper sewage treatment greatly impacts the quality of groundwater, surface waters, and coastal and marine waters. Improperly treated sewage discharges can contaminate the receiving water bodies with microorganisms that may give rise to waterborne diseases such as diarrhea, cholera, and dysentery.

In 2008, diarrhea ranked fourth among the leading causes of morbidity, affecting 434,445 people. It was also the eighth leading cause of infant deaths, affecting 937 infants, with a rate of 0.5 infant per 1,000 live births. The severity of waterborne diseases underscores the need for the protection and management of water quality, and public health, accordingly. In relation to this, the NSSMP was developed in the hopes of improving sewerage and sanitation in the Philippines, thereby, minimizing and/or eliminating the risks of waterborne diseases. One of the program's targets is the development of sewerage and septage management facilities, aiming to reduce around 346 million BOD loading by 2020.

In Metro Manila, 43 sewage treatment plants (STPs) and septage treatment plants (SpTPs) service more than a million residents or around nine percent of the region's entire population. Their BOD removal is presented in Figure 28. An average of 9.4 million kilograms of BOD was removed per year during this four-year period. The highest pollution load reduction was attained in 2012 with 9.5 million kilograms of BOD removed.

For the other parts of the country, an inventory of STPs and SpTPs (and consequently, their capacity, population served, and BOD removal) has yet to be completed as part of the NSSMP. Aside from this inventory, the NSSMP also aims to increase the number of households with access to piped sewerage systems. In relation to this, centralized STPs are to be constructed in the 17 Highly Urbanized Cities (HUCs) outside of Metro Manila (excluding Antipolo).

Figure 28. Pollution Load Reduction in Metro Manila, 2009 to 2012.



Source: MWSS, 2013.

CHAPTER 4

WATER QUALITY MANAGEMENT POLICIES AND PROGRAMS

Talibon, Bohol

Source: Elvera Venus Tandog

This section discusses the updates on the implementation of RA 9275 and its Implementing Rules and Regulations (IRR); legal and policy issuances related to water quality management; programs on water quality enhancement and rehabilitation; investments in sanitation, sewerage, and wastewater treatment; and initiatives on research and development (R&D) for the improvement of water quality in the country.

4.1 UPDATES ON THE IMPLEMENTATION OF RA 9275 AND ITS IRR

RA 9275, the principal regulation providing for a comprehensive water quality management, was enacted in 2004. Since then, the Government of the Philippines, through DENR, has gained headway in implementing its provisions. The progress of these provisions is presented in Table 8.

Table 8. Implementation Progress of the CWA of 2004.

Salient Features	Status	Description
Sec. 5 Water Quality Management Area (WQMA)	★	DENR Memorandum Circular (DMC) 2009-15 (Procedural Manual for the Designation of WQMA) was issued on 6 November 2009, describing the technical requirements in delineating and designating WQMAs. As of 2013, 17 WQMAs have been officially designated, aside from the areas within the jurisdiction of the Laguna Lake Development Authority (LLDA).
Sec. 6 Management of Non-attainment Areas	△	Procedural Guidelines for the Designation of Non-attainment Areas is undergoing the review process.
Sec. 7 National Sewerage and Septage Management Program (NSSMP)	★	NSSMP Main Report was released by the Department of Public Works and Highways (DPWH) on 25 September 2010. Phase implementation started immediately.
Sec. 8 Domestic Sewage Collection, Treatment and Disposal	△	• DOH Administrative Order (AO) 2010-0021 (Sustainable Sanitation as a National Policy and a National Priority Program of the DOH) was issued on 25 June 2010 to promote sustainable sanitation for all Filipinos. DOH aims that, by 2015, the proportion of the population without sustainable access to basic sanitation is reduced by 50%. • Guidelines for the Transport, Treatment, Storage, and Disposal of Effluent, Sewage, and/or Septage Offsite is undergoing the review and approval process of DENR.

Salient Features	Status	Description
Sec. 9 National Water Quality Management Fund (NWQMF)	★	DAO 2012-06 (Implementing Guidelines on the Operationalization of the NWQMF under RA 9275) was issued on 11 September 2012 to provide guidelines on the management, operationalization, disbursement, and monitoring of the NWQMF.
Sec. 10 Area Water Quality Management Fund (AWQMF)	★	DAO 2013-15 (Guidelines on the Operationalization of the AWQMF under RA 9275) was issued on 27 May 2013 to provide guidelines on the administration, management, and operation of the AWQMF appropriated to all WQMA.
Sec. 11 Water Quality Variance for Geothermal and Oil and Gas Exploration	▲	A study on the Development of Industry-Specific Effluent Standards for Offshore Oil and Gas Industry is being conducted by EMB.
Sec. 12 Categories of Industry Sectors in the Proposed Guidelines	▲	Categories of industries are included in the proposed General Effluent Standards that is undergoing the review and approval process of DENR.
Sec. 13/14 Wastewater Charge System and Discharge Permits	▲	Guidelines on the Wastewater Charge System and Discharge Permits are undergoing the review and approval process of DENR.
Sec. 17 Programmatic Environmental Impact Assessment (EIA)	▲	Programmatic EIA in local land use plans and area development plans are already being implemented in certain areas.
Sec. 26 Incentives Scheme	★	DAO 2013-17 (Guidelines for DENR Endorsement of Water Quality Management Projects under RA 9275) was issued on 27 May 2013 to guide EMB Regional Offices (ROs) in evaluating water quality management projects and form part of the requirements for the availment of incentives being administered by the Board of Investments of the Department of Trade and Industry and the Bureau of Internal Revenue.
Statutory Requirements		
Prepare National Water Quality Status Report (NWQSR) within 24 months	★	2001–2005 NWQSR (1st Issue) was released in 2007.
Prepare Integrated Water Quality Management Framework (IWQMF) within 12 months	★	DAO 2013-08 (Adoption of the IWQMF) was issued on 13 February 2013.
Prepare 10-Year WQMA Action Plan within 12 months following the completion of the framework for each designated WQMA	▲	10-Year WQMA Action Plan has been developed for the following: • Iloilo-Batiano River System WQMA • Marilao-Meycauayan-Obando River System WQMA • Sarangani Bay WQMA • Silway River WQMA • Sinocalan-Dagupan River System WQMA
Prepare and publish national groundwater vulnerability map incorporating the prevailing standards and methodologies within 24 months	▲	National groundwater vulnerability map is currently being prepared by the MGB of DENR.
Enforce, review, and revise water quality guidelines after due consultation with the concerned stakeholder sectors within 12 months	▲	Water Quality Guidelines and General Effluent Standards is undergoing the review and approval process of DENR.
Review and set effluent standards every five years		
Establish internationally-accepted procedures for sampling and analysis of pollutants and establish an accreditation system for laboratories within 12 months	★	• EMB MC 2008-08 Water Quality Monitoring Manuals (Volume I – Manual on Ambient Water Quality Monitoring and Volume II – Manual on Effluent Quality Monitoring) was issued in February 2008 to establish a uniform quality control and assurance program on ambient water and effluent quality monitoring. • From 2006 to 2007, DENR analytical methods for water/wastewater were revised, evaluated, and updated for inclusion in the proposed Water Quality Guidelines and General Effluent Standards. • As of December 2013, 71 laboratories have been recognized under the DENR Environmental Recognition Scheme.

Salient Features	Status	Description
Classify or reclassify all water bodies according their beneficial usages	▲	Classification and reclassification are part of on-going programs of DENR. As of 2013, EMB has classified/reclassified 688 water bodies (313 principal rivers, 301 minor rivers, 16 lakes, and 58 coastal and marine waters).
Sec. 22 Linkage Mechanism		
PCG to coordinate with DA and DENR to enforce water quality standards in marine waters specifically from offshore sources	★	PCG is implementing coastal and marine pollution management as required of their mandate.
DPWH through its attached agencies to provide sewerage and sanitation facilities	▲	Provision of sewerage and sanitation facilities included in NSSMP.
DA to formulate guidelines on the re-use of wastewater for agricultural uses and categorize discharges coming from non-point sources	★	DA AO 2007-26 (Guidelines on the Procedures and Technical Requirements for the Issuance of a Certification Allowing the Safe Re-use of Wastewater for Purposes of Irrigation and Other Agricultural Uses) was issued in August 2007 to allow the use of wastewater for irrigation, fertilization, and aquaculture activities after securing certification for safe wastewater re-use from the DA and discharge permit from EMB.
Department of Science and Technology (DOST) to prepare a program for the evaluation and verification of cleaner production technologies	★	DENR–DOST Joint AO 2006-01 (Adopting Environmental Technology Verification Protocol) was issued on 13 February 2006 to prescribe the Environmental Technology Verification Protocols with DOST as the primary implementing agency. The technology review and verification process ensures that new and modified technologies are environmentally sound.

Legend: ▲ On-going
★ Output manifested

4.2 LEGAL AND POLICY ISSUANCES RELATED TO WATER QUALITY MANAGEMENT

To further strengthen the implementation of RA 9275, supplementary regulations have been promulgated by DENR from 2006 to 2013. These include:

- **DAO 2012-07: Rules and Regulations Implementing Executive Order (EO) 79 Dated 06 July 2012 Entitled: Institutionalizing and Implementing Reforms in the Philippine Mining Sector, Providing Policies and Guidelines to Ensure Environmental Protection and Responsible Mining in the Utilization of Mineral Resources.** Promulgated towards the attainment of the six-point agenda adopted by the Climate Change Adaptation and Mitigation and Economic Development Cabinet Clusters, which sets the direction and lays the foundation for the implementation of Responsible Mining Policies to improve environmental mining standards and increase revenues to promote sustainable economic development and social growth, both at the national and local levels.
- **DAO 2010-21: Providing for a Consolidated DAO for the IRR of RA 7942, otherwise known as the Philippine Mining Act of 1995.** Promulgated the revised rules and regulations for the exploration, development, utilization, and conservation of mineral resources in adherence to the principle of sustainable mining and development that safeguards both the environment and the rights of the affected communities.
- **PAB Resolution 2010-01: Revised Rules of the PAB on Pleading, Practice and Procedure in Pollution Cases.** Applies to all pollution cases involving violation of pollution control laws and environmental laws and prohibited acts cognizable by the PAB for adjudication pursuant to Presidential Decree 1586, RA 6969, RA 8749, RA 9275, and RA 9003.
- **DMC 2009-002: Amending Revised Procedural Manual for DAO 2003-30 dated 30 June 2003 on the Classification of the Fast-food Stores, Restaurants and Similar Quick-Service Establishments.** Covers these establishments in the EIA System, hence the requirement to secure an Environmental Compliance Certificate and a Wastewater Discharge Permit (WWDP).

Several other laws and policies have also been promulgated by the national government and other government agencies in support to DENR's mandate on water quality management. These include:

- **RA 9512: Environmental Awareness and Education Act of 2008.** Promotes environmental awareness through environmental education and covers its integration in the school curricula at all levels, be it public or private, including day cares, preschools, non-formal, technical, vocational, indigenous learning, and out-of-school youth courses or programs. It also declared November as the Environmental Awareness Month in the Philippines.
- **RA 9729: Climate Change Act of 2009.** Mainstreams climate change into government policy formulations, establishes the framework strategy and program on climate change, and called for the creation of the Climate Change Commission.
- **RA 10121: Disaster Risk Reduction and Management (DRRM) Act of 2010.** Provides institutional framework and strategies for the prevention and management of disasters at local government levels. This is incorporated in the comprehensive ecosystem planning of the local governments.
- **EO 510: Creating the River Basin Control Office (RBCO)/EO 816: Declaring the RBCO under the DENR as the Lead Government Agency for the Integrated Planning, Management, Rehabilitation, and Development of the Country's River Basins.** Mandates the RBCO as the oversight agency for all government efforts and initiatives within the country's river basins.
- **Cabinet Cluster on Climate Change Adaptation and Mitigation Resolution No. 2012-001: Adopting the 18 Major River Basins in the Country as Priority Areas of the Government.** Declares the 18 major river basins in the country, adopted by member agencies of the Climate Change Adaptation and Mitigation Cabinet Clusters, as priority areas for government interventions.

4.3 PROGRAMS ON WATER QUALITY ENHANCEMENT AND REHABILITATION

Programs on water quality enhancement and rehabilitation in the Philippines are spearheaded by DENR and supported by other government agencies, non-government organizations (NGOs), financing institutions, and development partners. These programs are discussed hereafter.

4.3.1 DENR

Water quality management and rehabilitation programs spearheaded by DENR are presented in the succeeding subsections per attached bureau or agency.

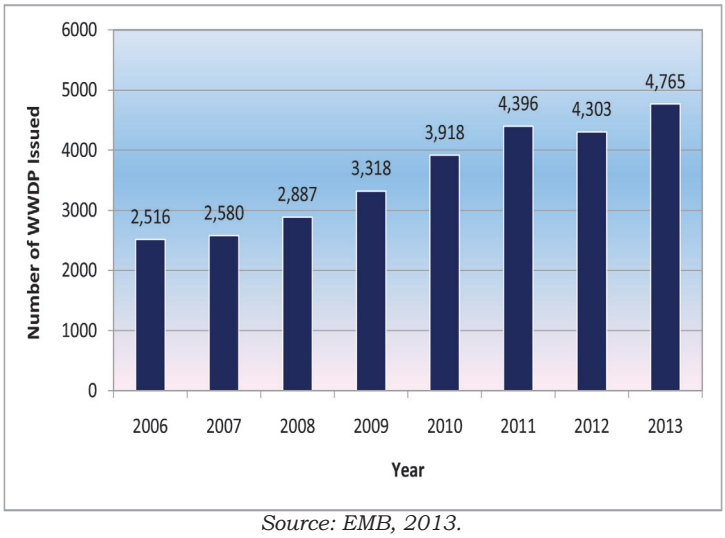
4.3.1.1 EMB

RA 9275 mandates DENR, through EMB, to be the national authority responsible for pollution prevention and control, and environmental impact assessment in pursuit of sustainable development. Its mission is to restore, protect, and enhance environmental quality towards good public health, environmental integrity, and economic viability, including the protection, preservation, and revival of the quality of the country's fresh, brackish, and marine waters by implementing the following activities, among others:

- Formulate policies and guidelines
- Issuance of WWDP
- Compliance monitoring of establishments
- Water quality monitoring
- Issuance of Notices of Violation (NOVs) and CDOs to facilities found in violation of RA 9275

In 2013, EMB issued 4,765 WWDP to establishments around the country, a 53-percent increase compared to the 2,516 WWDPs issued in 2006 (Figure 29).

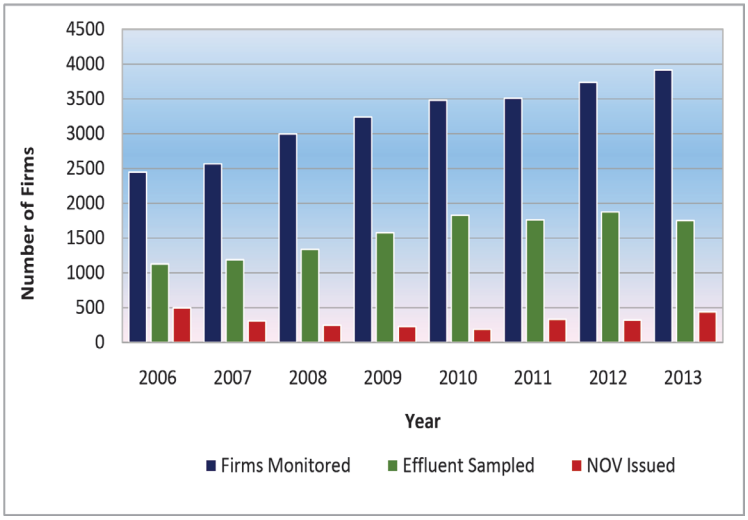
Figure 29. WWDP Issued from 2006 to 2013.



Source: EMB, 2013.

On the other hand, Figure 30 presents EMB's monitoring and enforcement updates from 2006 to 2013, including the number of establishments monitored, subjected to effluent sampling and analysis, and issued with NOVs.

Figure 30. EMB Monitoring and Enforcement Updates.



Source: EMB, 2013

The number of establishments monitored has increased from 2,449 in 2006 to 3,915 in 2013. Out of those monitored in 2013, 45 percent were subjected to sampling and analysis and 11 percent were issued NOVs.

Aside from executing compliance and enforcement activities, EMB implements the following water quality enhancement and rehabilitation programs:

- Adopt-an-*Estero*/Water Body Program
- Designation of WQMA
- Philippine Environment Partnership Program
- Public Awareness and Education Programs on Water Quality Management
- Industrial EcoWatch Program
- Beach Watch Program

Adopt-an-*Estero*/Water Body Program. Launched in 2010, the Adopt-an-*Estero*/Water Body Program aims to build partnerships among concerned sectors and organizations to restore the healthy state of waterways in the country, and to safeguard the well-being of its residents. It is a direct response to the continuing mandamus by the Supreme Court for agencies, including the DENR, to clean up the Manila Bay and priority waterways in other regions of the country.

As of 31 December 2013 and as formalized by 542 signed Memoranda of Agreement; 304 water bodies had been adopted all over the country. For more than three years, the Program, being true to what Secretary Ramon J.P. Paje had originally envisioned, has successfully proven itself as the forerunning program in terms of cleaning of water ways; conduct of information, education, and communication (IEC) campaigns; and monitoring of water quality improvements.

Successful clean-ups conducted as part of the program yielded immediate results as observed by local communities. Some of the results ranged from shortened flooding due to unimpeded water flow, to reduction of waterborne diseases during the wet season.

To sustain the achievements of the program, EMB conducts an annual Partners' Forum, where representatives from LGUs, the academe, civil society, and the private sector identify areas for improvement, as well as share best practices and technology options, to develop an action plan for the following year. The forum also serves to highlight the importance of private participation, and encourage citizens and partners alike to exert greater effort for the program.

Designation of WQMA. DENR has already designated 17 WQMA nationwide. Under the WQMA, the DENR and the stakeholders shall address the water quality problems, sources of pollution, and beneficial uses of the receiving water body. They shall also determine what control measures to institute to effectively achieve water quality objectives or improvements.

Rip Rapping of Concepcion Creek (Marikina)

Source: Marikina LGU, 2013.

The following watersheds, river systems, or coastal areas had been established as WQMA:

- Tigum-Aganan Watershed (DAO 2006-18)
- Marilao-Meycauayan-Obando River System (DAO 2008-07)
- Iloilo-Batiano River System (DAO 2009-11)
- Sarangani Bay (DAO 2009-12)
- Silway River (DAO 2010-10)
- Sinocalan-Dagupan River System (DAO 2011-14)
- San Juan River System (DAO 2012-04)
- Taguibo River (DAO 2012-11)
- Tumaga River (DAO 2013-01)
- Imus - Ylang-Ylang - Rio Grande Rivers (DAO 2013-02)
- Calapan River (DAO 2013-03)
- Davao River (DAO 2013-04)
- Balili River (DAO 2013-05)
- Pinacanauan de Tuguegarao (DAO 2013-06)
- Lake Buhi (DAO 2013-16)
- Cagayan de Oro River Basin and Adjacent Rivers (DAO 2013-18)
- Ormoc Bay and its Associated Watersheds (DAO 2013-21)

DENR is also tasked to create a governing board for each WQMA, which serves as a planning, monitoring, and coordinating body. In addition, DENR reviews the initial WQMA action plan prepared by EMB. Of the 17 WQMA, a 10-Year Action Plan has already been developed for the Iloilo-Batiano River System WQMA, Marilao-Meycauayan-Obando River System WQMA, Sarangani Bay WQMA, Silway River WQMA, and Sinocalan-Dagupan River System WQMA.

Philippine Environment Partnership Program (PEPP). Created by virtue of DAO 2003-14 (Creating the Philippine Environment Partnership Program to Support Industry Self-Regulation towards Improved Environmental Performance), the PEPP is a voluntary DENR partnership program with industries aimed to promote mandatory self-monitoring and compliance with environmental standards, as well as to encourage voluntary self-regulation among establishments.

Under the program, the PEPP evaluates and classifies establishments into "tracks" based on their environmental performance, and provides a package of incentives and assistance to encourage pollution prevention and cleaner production processes. The tracks or classifications are as follows:

- Track 1 – Companies that go beyond compliance and are driven by competitiveness, image, and supply chain requirements to improve performance. These are awarded with a DENR Seal of Approval and are entitled for the relaxation of regulatory requirements
- Track 2 – Companies that are currently unable to comply with regulations and are driven by survival needs (mostly small and medium business enterprises)

From 2009 to 2013, 32 companies have qualified for the program's Track 1 classification and have been awarded with the DENR Seal of Approval.

Public Awareness and Education Programs on Water Quality Management. EMB has initiated several major activities focused on public awareness and education on water quality management. These programs are summarized in Table 9.

Table 9. Public Awareness and Education Programs on Water Quality Management.

Program	Description
Information and Education Support on the Adopt-an-*Estero*/ Water Body Program	Several IEC activities had been initiated, such as, but not limited to, the following: • Conduct of annual Adopt-an-Estero/Water Body Program Partners' Forum • Conduct of annual EMB Central Office and RO Harmonization Workshop • Conduct of Nationwide lectures and seminars for adopters and communities • Conduct of regular river management council meetings • Photo-documentation and reporting of activities • Engagement of the National Service Training Program coordinators and students of universities and colleges nationwide Moreover, through EMB's Environmental Education and Information Division and in cooperation with its Water Quality Management Section, the following IEC support activities were initiated: • Production of refrigerator magnets, exhibit materials, flyers, and brochures • Production of the "Save Diliman Creek" and Adopt-an-*Estero*/Water Body Program videos • Production of music video on "*Ang Estero Mo'y Estero Ko*" with Noel Cabangon • Conduct of "*Lakbayan sa Tubig*" sessions in support of World Water Day, Earth Day, and World Environment Day celebrations • Conduct of Mural Painting Contests • Conduct of Exhibitions on the Adopt-an-*Estero*/Water Body Program • Initiated partnerships for the Community Mobilization Programs • Tapped participants of the Bayanihan Volunteer Groups of the DENR to participate in the program

Program	Description
Support to Manila Bay Rehabilitation	IEC support was initiated to include conduct of lectures and seminars among industries, training of pollution control officers (PCOs), production of 2013 Manila Bay desk calendar, and conduct of the 2013 World Water Day Concert.
IEC Support to the WQMA	Provided support by way of assistance in stakeholder consultations and conduct of lectures and seminars
Project Water Education for Teachers	In partnership with Nestle Philippines, Inc., trainings on water education were conducted in 2013 among high school and college teachers from various parts of Metro Manila. Similarly, the Nestle Water Leadership Awards; a biennial recognition scheme which aims to encourage schools in elementary, high school, and college levels to become more actively involved in environmental issues at a practical and local level; had been started as a special category in the 2013 National Search for Sustainable and Eco-friendly Schools.
Training of PCOs	Trainings of PCOs are regularly conducted in all regions on various environmental concerns, including the Philippine CWA of 2004.
International Coastal Clean-up	Promotes massive voluntary action to support and complement clean-up and greening activities of the government. This initiative is embodied in Presidential Proclamation 470, declaring the 3rd Saturday of September as the International Coastal Clean-up Day. Partners from different LGUs, academic institutions, NGOs, business sectors, and other private institutions join the government in this yearly endeavor which aims to protect, conserve, and manage the coastal and marine resources in the country.
Contests	EMB held a Facebook photo contest, dubbed as '*Kontribusyon Ko Para sa Malinis na Tubig*', in support of the 2012 World Water Day Celebration for residents of Metro Manila and the nearby regions.
Environmental Radio Programs	The 16 EMB Regional Offices maintain radio programs which include interviews, features, and discussions on water-related issues and concerns.

Source: EMB, 2013.

Industrial EcoWatch Program. Under DAO 2003-26, the Industrial EcoWatch Program was implemented as part of EMB's compliance monitoring system. This Program evaluates all establishments that discharge wastes into the environment and assesses their compliance to each applicable environmental regulation. The assessment summarizes this multi-sectoral evaluation into a single rating indicative of its general environmental performance. The rating is as follows (from best to worst): Gold, Silver, Green, Blue, Red, and Black. Of these, Red and Black classifications indicate violations in meeting the allowable parameters, while Blue is the minimum rating exhibiting satisfactory environmental performance.

From 2007 to 2012, EMB focused on four industry sectors: Beverages, Cement, Sugar, and Pulp and Paper. Establishments under these four sectors throughout the country were assessed for their environmental performance, primarily in terms of effluent and emission compliance. Table 10 presents the results of the assessment.

Beach Watch Program. One of the priority programs of EMB, the Beach Watch Program aims to establish baseline data and provide information on the present quality of beaches in the country. It also aims to inform resort/facility owners to institute measures in improving the quality of their respective bathing beaches; thereby, ensuring public health as well as tourism and economic growth brought by beach development.

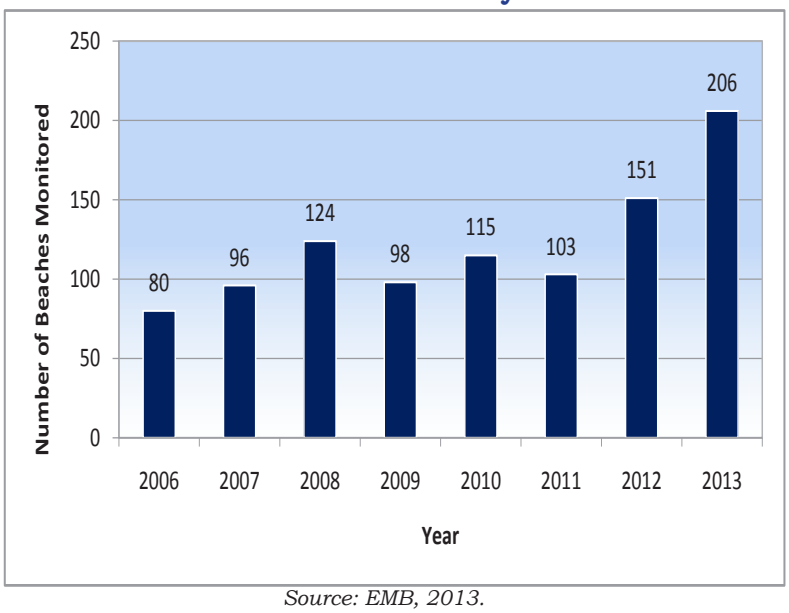
From 2006 to 2013, the number of monitored beaches under the Program (Figure 31) has increased from 80 to 206.

Table 10. Industrial EcoWatch Program Assessment Results, 2007 to 2012.

Rating	2007	2008	2009	2010	2011	2012	TOTAL
Black (Very Bad)	17	11	11	6	10	2	**57**
Red (Bad)	9	8	4	16	3	1	**41**
Blue (Good)	25	22	33	24	21	21	**146**
Green (Very Good)	16	17	13	9	9	5	**69**
Silver (Excellent)	8	12	9	14	9	9	**61**
Gold (Outstanding)	0	2	6	5	2	1	**16**
TOTAL	**75**	**72**	**76**	**74**	**54**	**39**	**390**

Source: EMB, 2013.

Figure 31. Number of Beaches Monitored Annually.



Source: EMB, 2013.

4.3.1.2 Manila Bay Coordinating Office (MBCO)

The MBCO was placed under the direct supervision of the DENR Secretary under DAO 2011-01 (Strengthening the MBCO). The directive ensured that appropriate focus was given to the delivery of obligations of the DENR to clean up Manila Bay, as ordered by the Supreme Court. It has coordinative functions among all offices and agencies involved in the bay's rehabilitation, restoration, and conservation. It also leads in the planning, monitoring, and review of all related activities and their progress, as well as in the preparation of reports required by the DENR and the Supreme Court.

4.3.1.3 MGB

To complement EMB's program on water quality management, MGB initiates the national groundwater resources and vulnerability assessment. The program aims to generate critical information and database on groundwater resources availability and vulnerability in the various regions and areas of the country; and make the information available to authorities responsible for water resources management and development, physical framework and land-use planning, land classification and allocation by LGUs, and regional as well as developmental projects. As of 2012, MGB has already implemented the program to 20 provinces and urban growth areas.

4.3.1.4 RBCO

The RBCO is mandated through EO 816 to take lead in and serve as the national coordinating office for integrated planning, management, rehabilitation, and development of the country's river basins.

Since its establishment, RBCO has:

- Developed a Philippine Integrated River Basin Management and Development Framework Plan
- Formulated an Integrated River Basin Management and Development Master Plan for five river basins: Cagayan River Basin, Mindanao River Basin, Buayan-Malungon River Basin, Agusan River Basin, and Central Cebu River Basin
- Improved coordination and collaboration by providing support and technical assistance in the creation, operationalization, and institutionalization of river basin organizations for the 18 major river basins and other priority principal river basins
- Initiated the implementation and data management for river basins using the River Basin Integrated Information and Management System

In addition, an ongoing formulation of 11 Major River Basin Plans and two Principal River Basin Plans are scheduled to be completed for CY 2014. Likewise, the Master Plans of three major river basins, namely: Pampanga, Agno, and Pasig-Laguna de Bay were also completed, which were initiated by NWRB, the former Agno River Basin Development Commission, and LLDA, respectively.

4.3.1.5 Forest Management Bureau

This Bureau was created in June 1987 under EO 192 to ensure the effective protection, development, occupancy management, and conservation of forestlands and watersheds. Its major projects and programs are discussed hereafter:

- **Watershed Management Project.** Focuses on watershed characterization, vulnerability assessment, soil and water conservation measures, and integrated watershed management planning, with the end goal of achieving sustainable watershed management, which will reduce the potential occurrence of flashfloods during heavy and prolonged rainfall.
- **National Greening Program (NGP).** Declared through EO 26 in February 2011, NGP aims to plant 1.5 billion trees covering about 1.5 million hectares of denuded/designated areas for a period of six years from 2011 to 2016, while using the watershed as the basic planning unit. By taking this approach, the hydrological and ecological functions of a watershed are maximized. This will also give the greatest impact in mitigating soil erosion and geohazards that especially affect the downstream areas. As of 2013, a total of 683,481 hectares nationwide were planted under the Program.

Box 5. The Manila Bay Writ of Continuing Mandamus

A decision known as the Writ of Continuing Mandamus was issued in 2008 by the Supreme Court, which ordered government agencies to clean up, rehabilitate, and preserve Manila Bay; and to restore and maintain its waters to the Class SB level (under DAO 1990-34) to make them fit for swimming, skin diving, and other forms of contact recreation. An important mandate of the decision is the Implementation of the Operational Plan for the Manila Bay Coastal Strategy (OPMBC). The OPMBC delineates the tasks and objectives that should be accomplished by the petitioners for the improvement of the quality of Manila Bay. Being the lead agency of the OPMBC, the DENR, through EMB, has monitored 28 stations in Manila Bay as well as 16 river systems draining into Manila Bay, consisting of 83 sampling stations.

Based on the 2013 accomplishment report, EMB monitored 19 bathing beaches from the endways of the Manila Bay Coastline (Table B-1). These stations were monitored for their DO, Total Coliform, and Fecal Coliform. As shown in Table B-1, 15 of 19 stations passed the DO criterion of 5 mg/L for a Class SB water body. The four stations which failed to meet the DO criterion are all located along the coastline of NCR. In terms of Total Coliform, the stations along Dalaroy's Resort in Cavite passed the 1,000 MPN/100mL criterion for Class SB, while the remaining 18 stations failed to meet this criterion. On the other hand, none of the stations conformed to the 200 MPN/100mL Fecal Coliform criterion for Class SB.

In addition, nine baywide stations (Figure B-1) are being monitored strategically (Table B-2). Each station was monitored for DO and samples were taken at the surface, middle, and bottom depths. A decreasing trend from top to bottom in all nine stations was observed, with only the surface and bottom depths consistently conforming to the DO criterion. However, only four stations passed the criteria at the bottom, with values as low as 3.6 mg/L.

Table B-1. Monitoring Results of Bathing Beaches, 2013.

Station	DO (mg/L)	Total Coliform	Fecal Coliform
		MPN/100 mL	
Navotas Fish Port	4.6	280,000	1,600,000
Luneta Park	2.6	54,000	92,000
CCP	4.7	16,000	540,000
MOA	2.7	35,000	54,000
PEATC	6.2	160,000	16,000
Bacoor, Cavite	6.3	42,506	18,331
Noveleta, Cavite1	7.7	51,706	9,813
Noveleta, Cavite2	7.6	42,284	10,301
Rosario, Cavite	7.6	209,659	19,206
Tanza, Cavite1	8.0	42,595	10,720
Tanza, Cavite2	6.8	12,387	3,179
Naic, Cavite1	7.7	57,690	6,719
Naic, Cavite 2	7.8	42,595	19,381
Antonio's Hideaway	7.9	2,747	1,358
Dalaroy's Resort	8.1	768	393
Mariveles, Bataan1	5.3	6,197	4,699
Mariveles, Bataan2	5.8	13,748	11,068
Limay, Bataan1	5.0	23,664	23,664
Limay, Bataan2	6.1	25,377	12,652
DENR WATER QUALITY CRITERIA	5 (minimum)	1,000	200

Source: MBO, 2013.

Figure B-1. Baywide Monitoring Stations, 2013.

Source: MBO, 2013.

Table B-2. Monitoring Results of Baywide Stations, 2013.

Station	DO (mg/L)		
	Surface	Middle	Bottom
1	8.6	6.9	3.6
2	8.8	7.5	4.7
3	10.8	6.9	5.8
4	9.6	7.8	6.4
5	8.9	7.1	4.8
6	8.8	7.2	6.0
7	10.3	8.1	4.5
8	8.4	7.0	7.5
9	7.8	5.7	4.6

Source: MBO, 2013.

Box 6. Groundwater Resources and Vulnerability Assessment of Pampanga Province.

The groundwater resources and vulnerability survey of Pampanga Province was conducted in March 2011. Wells and springs information was collected from waterworks and water district offices in the 20 municipalities and two cities of Pampanga. Water level measurements as well as physical/chemical determinations were conducted for a total of 238 wells. A geo-resistivity survey was also conducted to complement the subsurface data from inventoried wells and to determine possible seawater contamination along the coastal municipalities of Pampanga. A total of 40 Vertical Electrical Sounding points were laid out strategically within the study area.

The results of the geo-resistivity survey and analysis of collected well data showed that Pampanga has relatively thick (18 to 100 meters) and extensively productive aquifers, which persist below 200 meters. Tapped aquifers occur from three meters to greater than 200-meter depths. Low resistivity layers indicating possible seawater contamination/ intrusion have been encountered at near surface to less than a 50-meter depth in resistivity soundings in municipalities which lie in the southern part of Pampanga bordering Manila Bay.

4.3.1.6 LLDA

LLDA was created by RA 4850 (An Act Creating the LLDA, Prescribing its Powers, Functions and Duties, Providing Funds Thereof, and for Other Purposes) and was mandated to attain sustainable ecological management within the Laguna de Bay Region. Several special projects of LLDA on water quality management include the following:

- **Laguna De Bay Institutional Strengthening and Community Participation (LISCOP) Project.** With assistance from WB, LISCOP finances construction of infrastructure by LGUs, including wastewater treatment facilities, to address discharging of polluted wastewater into the lake and tributary rivers. The project also enabled LLDA to expand the Environmental Users Fee, resulting to reduced average industrial BOD loading from 24.34 to 1.29 metric tons per firm.
- **River Rehabilitation Program.** Organizes River Basin Councils all over the lake. The "Environmental Army", a group of community volunteers, helps LLDA in various river clean-ups of clogged waterways and tributaries that drain into the Laguna de Bay. From 2010 to 2012, nine river clean-ups were conducted, during which a total of 1.924 sacks or 29.6 tons of garbage were collected in 2012.
- **Shoreland Management Program.** Designed to control pollution and nuisance through the elimination of incompatible elements and uses of the Laguna de Bay Shoreland Areas. In 2012, LLDA issued a total of 64 NOVs for illegal backfilling and construction activities in shoreland areas. Majority of the illegal activities discovered, however, were due to informal settlers.

4.3.1.7 NWRB

The NWRB is responsible for ensuring the optimum exploitation, utilization, development, conservation, and protection of the country's water resources, consistent with the principles of the Integrated Water Resources Management (IWRM).

In November 2008, NWRB, in collaboration with the Japan International Cooperation Agency (JICA), initiated a study on the IWRM for Poverty Alleviation and Economic Development in the Pampanga River Basin. The IWRM was necessary to cope with growing water demand due to increase in population, expansion of irrigation area, and development of industry as well as frequent flooding. From the study, a plan for the IWRM of the Pampanga River Basin was formulated, and relevant skills and technologies on IWRM were transferred to NWRB personnel and other concerned agencies.

4.3.2 Other Government Agencies

Other government agencies supporting the water quality enhancement and rehabilitation programs of DENR are presented in the succeeding subsections.

4.3.2.1 Local Water Utilities Administration (LWUA)

LWUA was created through Presidential Decree 198, otherwise known as the Provincial Water Utilities Act of 1973, to promote and oversee the development of water supply systems in provincial cities and municipalities outside of Metropolitan Manila. Special projects of LWUA are discussed hereafter:

- **Groundwater Data Research and Monitoring.** LWUA assists water districts through the Research Division - Water Resources Research and Training Department by undertaking groundwater monitoring, assessment, and research studies; as well as managing and maintaining the agency's computerized

groundwater data bank, among others. The groundwater data banking and monitoring system aimed to institutionalize groundwater data banking at the water district level and utilize the data bank as a tool in groundwater management and in assessing groundwater availability through the establishment of a continuing monitoring program for groundwater levels, extraction rates, and water quality conditions.

- **Development of Water Safety Plan (WSP).** In collaboration with WHO and with support from the Australian Agency for International Development, LWUA initiated in 2006 the development and implementation of the WSP in the country. The program involved the conduct of a comprehensive risk assessment and risk management approach to identify design risks and improvements in the country's water systems, thereby, ensuring the safety and acceptability of drinking water supply. Through this approach, 190 water districts were trained, from which nine WSPs (serving 15 million people) were completed and 15 WSPs were drafted.

4.3.2.2 DPWH

As mandated by RA 9275, the DPWH prepared the NSSMP to improve water quality and protect public health in urban areas by 2020. The NSSMP aimed to enhance the ability of local implementers to build and operate wastewater treatment systems for urban centers and to promote the behavioral change and supporting environment needed for systems to be effective and sustainable.

To initiate the effective implementation of the NSSMP, the DPWH created an NSSMP Office to lead the nationwide training and promotions campaign using the Program Operations Manual: Support for the Nationwide Roll-out of the NSSMP (March 2013) and the toolkits contained in the NSSMP Guide for Local Implementers.

4.3.2.3 Pasig River Rehabilitation Commission (PRRC)

The PRRC was created in January 1999 by virtue of EO 54 to spearhead the rehabilitation of Pasig River to its historically pristine condition, conducive for the propagation of fishes and other aquatic resources, transport, recreation, and tourism. In 2013, PRRC has rehabilitated a total length of 4,141 meters (106% accomplishment against the target of 3,904 meters) along the main Pasig River and tributaries; reduced the BOD level by 200 percent (15.6 mg/L accomplishment against the target 25% reduction); and relocated 1,045 informal settler families along the Pasig River System.

In line with its goal to revive Pasig River, PRRC has also focused its efforts on the rehabilitation of *Estero de Paco*, one of the tributaries of Pasig River. The *estero* is highly polluted with solid and sewage wastes coming from nearby institutions, commercial facilities, and residential areas, which result to its black-colored waters and strong foul odor.

Estero de Paco

Source: PRRC, 2013.

Box 7. IWRM of Pampanga River Basin.

A Study on IWRM for Poverty Alleviation and Economic Development in Pampanga River Basin between NWRB and JICA started in November 2008 to:

- Formulate a plan for the IWRM of the Pampanga river basin
- Transfer relevant skills and technologies on IWRM to personnel of NWRB and other concerned organizations

The Pampanga river basin is the fourth largest river basin, with one of the greatest irrigation area in the Philippines. Two major reservoirs, Angat and Pantabangan, have been operated to provide water for irrigation, domestic, and hydropower as well as flood control.

The IWRM was necessary to cope with growing water demand due to increase in population, expansion of irrigation area, and development of industry as well as frequent flooding.

Box 8. NSSMP Targets for Areas outside Metro Manila.

Target 1: By 2020, all LGUs have developed septage management systems and the 17 highly urbanized cities have developed sewerage systems

Target 2: By 2020, approximately 43.6 million people have access to SpTPs and about 3.2 million will have access to STPs

Target 3: By 2020, PhP 26.3 billion has been invested in sanitation improvement projects

Target 4: By 2020, about 346 million kg of BOD is diverted from the environment per year as a result of the sewerage and septage management projects

To improve the water quality of the *estero*, PRRC entered into a partnership with Maynilad Water Services, Inc. (MWSI) and Manila Water Company, Inc. (MWCI) for the construction of interceptors that will treat sewage water before flowing into the *estero*. It also conducts regular water quality monitoring to assess the effects of these rehabilitation works. Results of the monitoring are also used as a basis for the development of appropriate actions in addressing water quality issues of the *estero*.

With the 2011 monitoring data as baseline, PRRC reported improvement in the 2013 concentration levels of the following parameters: DO, BOD, TSS, surfactants, oil and grease, ammonia, phosphates, chromium, cadmium, lead, mercury, Total Coliform, and Fecal Coliform. On the other hand, the parameters that showed no improvement were nitrates, phenolic substances, and cyanide. Among these, only five parameters met their corresponding water quality criteria for Class C water bodies, namely: TSS, nitrates, chloride, chromium, and mercury.

As a result of the monitoring, PRRC recommended to conduct regular and thorough clean-up activities in *Estero de Paco*.

4.3.2.4 Metro Manila Development Authority (MMDA)

Under RA 7924, MMDA is tasked to provide services which have metrowide impact and transcend legal political boundaries or entail huge expenditures such that it would not be viable for the said services to be provided by the individual LGUs within Metro Manila. Projects initiated by MMDA for water quality improvement are:

- ***Lingap sa Barangay* and *Linis Palengke* Project.** Cleaning and greening projects focused on solid waste management, declogging of canals, *esteros*, and drainage lines.
- ***Estero* Blitz.** An intensified operation campaign covering selected *esteros* in Metro Manila. The campaign involved the dredging, removal, and hauling of garbage, spoils, and other debris in the waterways as well as seminars on health and sanitation.

MMDA also supports and participated in various inter-agency activities like the "Adopt-an-*Estero*/ Water Body Program" of DENR, "One Day, One Bay" of the Department of Interior and Local Government, International Coastal Clean-up, and relocation of informal settlers along waterways.

4.3.3 NGOs

Some of the NGOs supporting the water quality management and rehabilitation programs of the government are presented in the succeeding subsections.

4.3.3.1 Philippine Center for Water and Sanitation – International Training Network Foundation (PCWS-ITNF)

PCWS-ITNF provides technical assistance to LGUs, communities, and NGOs in the assessment of the local water and sanitation situation; undertakes water resources inventory; develops and implements action plans for water supply, sanitation, and hygiene as well as engineering design of specific water supply and sanitation systems.

PCWS-ITNF, with partner NGOs, communities, schools, and individuals also implements the construction of low-cost, ferro-cement wastewater treatment (Figure 32). PCWS-ITNF promotes biogas digesters for sanitation, waste management, water treatment, and production of clean renewable energy.

These technologies support the efforts of urban and rural poor communities to provide good quality water and sanitation services.

Figure 32. Low-Cost Ferro-Cement Wastewater Treatment for Communities and Households.

Source: PCWS-ITNF, 2013.

4.3.3.2 Philippine Center for Population and Development (PCPD)

The PCPD is an organization that believes that development can only be sustainable if a proper balance is maintained between the country's population and resources. One of its projects is the GIS-based Climate Change Vulnerability and Adaptation and Risk Assessments for Metro Cebu. Given reports of groundwater depletion and saltwater intrusion, this project aims to study how climate change impacts groundwater resources in Metro Cebu by providing vulnerability maps and risk assessments regarding the water sector that can contribute to the design of strategic climate change adaptation options.

By partnering with the University of San Carlos-Office of Population Studies (USC-OPS) and the Manila Observatory, PCPD will enable the development of USC-OPS as a Disaster Risk GIS Academic Hub in Visayas. All software and hardware that will be used for the project will be made available for use by USC-OPS.

4.3.4 Financing Institutions

Some of the financing institutions supporting the water quality management and rehabilitation programs of the government are presented in the succeeding subsections.

4.3.4.1 Development Bank of the Philippines (DBP)

DBP pursues its commitment to environmental protection and sustainable development. It provides various credit and technical assistance to eligible borrowers, among which are the Environmental Protection and Management Facility; and Water Supply and Sanitation Services.

Environmental Protection and Management Facility. This credit facility focuses on environmental technologies and techniques geared towards reducing wastes and pollution. Priority projects under this facility include:

- Industrial Pollution Prevention or Reduction Projects
- Cleaner Technology Investments
- Pollution Abatement Technologies
- Solid Waste Management
- Sanitary Landfill
- Materials Recovery Facilities
- Waste Segregation or Reduction

Based on the 2009 Environmental Performance Monitoring of DBP, several environmental benefits related to water quality conservation were achieved by its borrowers under this credit facility. These include the following:

- Avoided the discharge of 1,310 metric tons of organic pollution (equivalent to the pollution loading contributed by about 71,827 individuals)
- Conserved 3,739 metric tons of various raw materials used for production
- Conserved 12 million cubic meters of water, which is enough for the needs of about 106,000 Filipinos in a year

Sample of Eligible Projects under the Environmental Protection and Management Facility

Source: DBP.

Water Supply and Sanitation. To boost investments in the water supply and sanitations sectors, DBP financed 12 water projects (amounting to PhP 456 million) in 2009 that aimed to supply 11,544 service connections and 57,720 households. Notable among these initiatives is the water supply project of LGU-Isabel, Leyte; which enabled the Isabel Water District to supply water for the central barangays of the municipality, industries inside the Leyte Industrial Development Estate, and coastal barangays through the Barangay Water Cooperative Association.

Using its internally generated funds and second generation funds, DBP also granted the Metro Cebu Water District a PhP 1.25 billion loan to refinance its loan from the LWUA that helped enhance its water district. Through DBP's assistance, the water district completed a total of 116,417 service connections, serving four cities and four municipalities.

4.3.4.2 Land Bank of the Philippines (LBP)

LBP is a government financial institution that strikes a balance in fulfilling its social mandate of promoting countryside development, while remaining financially viable. In support of the national government priority programs, including public-private partnership projects, LBP provides loans to environment-related projects including clean and renewable energy.

About nine percent of the total loan portfolio of LBP is allocated to this sector. Additionally, LBP pursues water quality management initiatives such as the Adopt-a-Watershed Project and the Manila Bay Socially Responsible and United in Nurturing and Sustaining the Environment (SUNSET) Partnership Program, Inc.

Adopt-a-Watershed Project. A joint venture between LBP and DENR, this project restored 14 ha of denuded forestlands in six pilot areas nationwide, namely: Angat-Ipo River (Bulacan), Bago River (Negros Occidental), Binahaan River (Leyte), Lasang River (Davao del Norte), Magat River (Nueva Viscaya), and Silway River (South Cotabato).

Following the success of the project, LBP and DENR renewed their partnership in 2012 through a tripartite agreement with respective people's organizations for a three-year "Adopt-a-Watershed Program II (2012-2015)". For its second phase, the project aims to rehabilitate 40 ha of denuded forests in six sites (two sites each in Luzon, Visayas, and Mindanao) as a contribution to the National Greening Program of the Aquino Administration. In 2013, 55,600 seedlings of fruit-bearing trees were planted in selected watersheds.

Manila Bay SUNSET Partnership Program, Inc. As part of LBP's commitment to the Manila Bay Declaration in 2001, the MBSPPI was established in 2008 as the flagship program of LBP on Corporate Social Responsibility and is the first public-private, multi-sectoral partnership organized to help implement a sustainable approach to clean and protect Manila Bay.

In its 10th year of implementation in 2013, three quarterly clean-ups, alternately led by different partner-institutions with the support of LBP, were conducted. A total of 3,800 volunteers collected 25 dump trucks (7,500 sacks) of trash, which is 22 percent higher than the 21 dump trucks (6,134 sacks) collected in 2012 by 1,318 volunteers.

4.3.5 Development Partners

The Philippines is a recipient of development assistance for water quality management. Its main development partners and their activities are discussed hereafter.

4.3.5.1 JICA

JICA's assistance paved the way for major advancements in Philippine water quality management. These advancements were manifested primarily through a five-year Capacity Development Project on Water Quality Management (CDPWQM) which started in October 2005.

Through the CDPWQM, JICA provided extensive assistance to enhance the capacity of EMB in policy formulation, standard-setting, and decision-making. The CDPWQM allowed various efforts in water quality management to take root in the country. The multiple facets of the assistance spanned the following:

- Preparation of Regional and National Water Quality Status Reports for Public Information and Advocacy
- Formulation of the IWQMF
- Finalization of the Revised Water Quality Guidelines and Development of Effluent Standards
- Development of Industry-Specific Effluent Standards
- Finalization and Harmonization of Discharge Permitting and Wastewater Charge System
- Operationalization of the Water Quality Management Funds
- Revision of Guidelines for PCO Accreditation and Compliance Inspection Manual
- Policy Review of the Philippines Effluent Management Strategy
- Guidelines for the Designation of WQMA

In its entirety, the CDPWQM was designed to strengthen the capabilities of EMB Central Office and Regional Offices in implementing 40 priority activities mandated to the DENR by the Philippine CWA and its IRR. Evidently, the project caused the realization of several mandates of the CWA and allowed for further development through offshoot and resultant projects.

Various activities under the JICA CDPWQM

Source: Innogy, 2011.

4.3.5.2 Asian Development Bank (ADB)

Grants and loans provided from ADB on water quality management in the Philippines include the following:

- **Design of a Pilot Project to Improve Environmental Conditions of *Estero de Paco*, 2012-2014.** The outcome of the technical assistance will be a design of a pilot facility that will allow for its later development and describe a management system to guarantee its sustainability and replicability to other *esteros*. The project aims to improve the water quality and environment in the *esteros* of Pasig River.
- **Urban Water Supply and Sanitation Project, 2011-2014.** With a budget of US$ 2 million, the technical assistance is intended to improve access to water supply and sanitation services in the cities of Cebu and Davao by 2022. The service coverage of Metro Cebu Water District and Davao City Water District, providing access to continuous water supply, will increase from 50 to 80 percent of the population, while the coverage of access to hygienic sanitation will increase from 10 to 50 percent.
- **Integrated Coastal Resources Management, 2007-2014.** Budgeted at US$ 62.3 million, the project aims to enhance coastal resources and reduce poverty among municipal fisherfolks. The project was implemented in seven priority marine biodiversity corridors and ecosystems, covering 80 municipalities in the provinces of Cagayan, Cebu, Davao Oriental, Masbate, Romblon, Siquijor, and Zambales.
- **Pasig River Catchment Sewerage Project, 2009-2011.** A technical assistance provided to MWCI for the increased coverage of sewerage and sanitation services in the east zone of Metro Manila.

4.3.5.3 United States Agency for International Development (USAID)

Based on the Country Development Cooperation Strategy (2012-2016), USAID will pursue an integrated, synergistic approach to reducing disaster vulnerabilities on selected areas in the Philippines. USAID will support the conduct of vulnerability assessments to identify which areas are most subject to climate change risks (e.g., drought, flooding, and landslides) and which critical sectors (e.g., agriculture and infrastructure) will most likely suffer.

Potential activities to strengthen long-term climate resilience include:

- Building local capacity to collect and utilize meteorological data for planning and policy-making in the areas of watershed management, DRRM, and water supply services
- Strengthening LGU capacities in preparing DRRM, water security, and watershed management plans
- Strengthening local capability for disaster preparedness
- Conducting IEC campaigns to raise public awareness on disaster risks and promote positive environmental behaviors
- Providing technical assistance for forestry to reduce flooding
- Strengthening flood forecasting and warning systems

4.3.5.4 World Bank (WB)

The WB has consistently supported the Philippines in various water quality management projects. These are discussed in the succeeding paragraphs.

Metro Manila Wastewater Management Project. WB approved a US$ 275 million budget for the improvement of wastewater collection and treatment practices in several catchment areas of Metro Manila that will help improve Manila Bay's water quality. The project will support investments of the two water concessionaires – MWCI and MWSI – to increase collection and treatment of wastewater from households and other establishments in the metropolis. Both MWCI and MWSI have planned a 25-year program for ensuring 100 percent wastewater collection and treatment for Metro Manila. The project has two components, namely:

- Investments by MWCI (US$ 193.4 million) comprising an STP and associated sewage lines covering North and South Pasig
- Investments by MWSI (US$ 178.3 million) in STPs and associated wastewater conveyance systems in Quezon City, Pasay, Muntinlupa, Valenzuela, and an SpTP in the southern part of Metro Manila

Integrated Persistent Organic Pollutants (IPOPs) Project. The objective of this project is to assist the Philippines in meeting its obligations under the Stockholm Convention for PCBs, Unintentionally-produced Persistent Organic Pollutants (UPOPs), and contaminated sites. It further aims to contribute to the development of capacity for the sound management of chemicals in the Philippines and aims to reduce/mitigate their harmful release and impacts in all environmental compartments, including water.

It has five components, namely:

- Strengthening regulatory framework and capacity building for POPs monitoring
- Reduction of releases of UPOPs
- Management of PCBs
- Identification and remediation of POPs contaminated sites
- Project management

4.4 INVESTMENTS IN SANITATION, SEWERAGE, AND WASTEWATER TREATMENT

Sanitation has long been regarded as a private responsibility in the country, resulting to only 10 percent of the country's population connected to sewerage systems. This sewerage problem leads to more than PhP 78 billion of economic losses annually.

According to DOH, 55 people die daily from diseases caused by lack of proper sewerage and sanitation facilities. These diseases include leptospirosis, malaria, dengue, hepatitis A, hepatitis E, and typhoid fever. The USAID also released a concept paper on sewerage and sanitation in the country, entitled "Water Supply and Sanitation Project Development Facility", under the Philippine Water Revolving Fund Support Program. It was reported that investments in water and sanitation in the country are lagging as only 44 percent of the population have access to safe Level 3 water supply.

Several projects implemented by the government in joint partnership with funding institutions and private organizations are discussed hereafter.

4.4.1 *Sagana at Ligtas na Tubig sa Lahat (SaLinTubig)* Project

Aiming to provide water supply systems to the 455 waterless municipalities all over the country, this program is led by the National Anti-Poverty Commission in cooperation with DOH and the Department of Interior and Local Government. The program aims to increase water service for the waterless population by 50 percent, reduce the number of waterborne and sanitation-related diseases by 20 percent, improve access of the poor to sanitation services by at least 10 percent, and establish sustainable operation of all facilities

4.4.2 LISCOP Project

A 15-year development undertaking of the LLDA funded by WB and the Netherlands to improve the environmental quality of the Laguna Lake and its watershed through a "solution-in-my-backyard" approach. The project assists LGUs in implementing environmental sub-projects such as material recovery facilities (MRFs), conversion of dumpsites into landfills, watershed management, and wastewater treatment.

In Sta. Cruz, Laguna; an initiative supported by LISCOP is the construction and operation of a Decentralized Wastewater System (DEWATS) that treats wastewater from the town's slaughterhouse prior to discharge into the river (Figure 33). Biogas is also harvested from the treatment facility that is used by the workers in cooking their food and boiling water. The DEWATS started to operate in September 2009. Parallel to its operation, wastewater samplings were conducted to establish and monitor system efficiency. In cognizant to the performance of the facility, samples analyzed revealed a 37.3-percent and 80.5-percent reduction of BOD and TSS, respectively, relative to the standards stipulated in DAO 1990-35.

The same funding was extended by LISCOP to Paete, Laguna. Instead of an anaerobic treatment system, wastewater will be treated with constructed wetlands being built at present.

Figure 33. LISCOP Sub-project in Sta. Cruz, Laguna.

Source: LISCOP, 2009.

4.4.3 Philippine Sanitation Alliance (PSA)

PSA was a four-year program of the USAID, which was established in October 2007 and ended in September 2011. It helped implement some of the provisions of RA 9275 by protecting biodiversity and reducing health risks through:

- Promoting the adoption of low-cost sanitation technology (for households, hospitals, hotels/restaurants)
- Helping package projects and access financing
- Promoting hygiene

The PSA worked with 10 cities and four water districts. Its major project was the Dumaguete Market and Septage Management Program, wherein a wastewater treatment plant (WWTP) for public market was constructed consisting of an anaerobic baffled reactor and constructed wetland. The WWTP treats septage from 22,000 households and 2,500 businesses in the lagoon system. It has a capital cost of US$ 510,000 and an annual operating cost of US$ 70,000.

4.4.4 ADB Technical Assistance on Water Supply and Sanitation Projects

ADB has more than three decades of partnership experience in supporting the development of water supply services in Metro Manila. One of the latest projects was the Metropolitan Waterworks and Sewerage System New Water Source Development from January 2004 until April 2008. The New Water Source Development Project conducted feasibility studies for Wawa River as a water source, Angat Water Utilization and Aqueduct Improvement, and Laiban Dam Preparatory projects.

4.4.5 WB-funded Manila Third Sewerage Project (MTSP)

Succeeding the completion of the Manila Sanitation and Sewerage Project (1990) and the Manila Second Sewerage Project (2006), WB initiated the MTSP, which is expected to increase sewerage coverage and sanitation services in the eastern portion of Metro Manila from about eight to 30 percent. An estimated 3.3 million residents in the eastern section of Metro Manila benefited from this Project. The project has three components. These are:

- **Sewage Management.** Construction of five STPs, upgrading of two communal septic tanks (CSTs) to secondary treatment, and rehabilitation and construction of collection networks. As of 2013, Capitolyo, Poblacion, Olandes, Pinagsama, and Pineda STPs have been completed, while the CSTs in East Avenue and Road 5 have been upgraded to STPs.
- **Septage Management.** Construction of two SpTPs, and safe disposal of treated septage. The North (San Mateo) and South (FTI) SpTPs were completed in 2007.
- **Institutional Strengthening.** Carries out public information campaign on the benefits of sewerage and sanitation services, and on the best practices of proper disposal of sewage; and assistance in preparation of follow-up programs for wastewater and sanitation improvements.

Table 11 presents the quantitative indicators, targets, and results of the MTSP (as of 2012).

Table 11. Indicators, Targets, and Results of MTSP (as of 2012).

Indicator	Target	Results (as of 2012)
Number of water connections in MWCI service area with sewage treatment service	49,500	Total:177,922 Attributed to MTSP facilities: 77,137
Volume of sewage treated before disposal (m^3/year)	113,227	Total: 117,817 Attributed to MTSP facilities: 11,499
Number of septic tanks desludged in MWCI service area	250,560	Total:518,158 Attributed to MTSP facilities: 262,012
Volume of septage treated before disposal (m^3/year)	982,800	Total:963,412 Attributed to MTSP facilities: 847,343
Percent increase in take-up rate of desludging service (% take-up rate /year)	No target identified	13 % (MTSP only)
Note: The target is attributable to MTSP and non-MTSP facilities.		

Source: WB, 2013.

4.4.6 LGU Urban Water and Sanitation Project APL2

This project aimed to reach approximately 40 LGU-operated water systems, which were given technical assistance and financial support. The four components of the project are the following:

- Finance civil works, equipment, and supervision for improved water supply systems in LGUs, including private sector participation where feasible
- Finance improved sanitation infrastructure
- Investment and assistance in micro-drainage infrastructure
- Funds for the hiring of a construction consultant

WB decided to contribute US$ 30 million to the project, while a portion is financed by local institutions. The project began in 2001 and ended in 2008.

4.4.7 Democratic Local Governance in Southeast Asia (DELGOSEA)

Launched in March 2010, the project is co-funded by the European Commission and the Konrad-Adenauer-Stiftung of Germany through the German Ministry for Development Cooperation. The project is a network of Local Government Associations, NGOs, local authorities, and academic institutions in the Philippines, Indonesia, Vietnam, Thailand, and Cambodia, focusing on transnational exchange of sustainable good governance practices in four main areas: people's participation in planning and decision-making; institutional governance; urban environment; and fiscal management and investment promotion strategies.

Within 32 months of project duration until October 2012, the project selected 16 good governance's best practices and further facilitated best practice replication in pilot cities in the five partner countries. The "One Pangasinan Alliance of LGUs (OPAL)", an alliance of one city and six municipalities in the Philippine island of Luzon based around the city of Alaminos, benefitted from this project.

OPAL replicated the best practice from Udonthani, Thailand where a wetland for wastewater treatment was constructed. In principle, wastewater from commercial or residential building will be channeled to the constructed wetlands. The wetlands have compartments and plants to treat water until, after three stages, water is released back to the canal system that will ultimately drain into the waters of the Hundred Islands National Park. Water will not only be clean, but will also be productive as it can now be used for agriculture and even for other household activities, except for drinking. By the end of the official DELGOSEA project period, the construction of the wetland had begun in Alaminos City and is progressing well.

4.5 INITIATIVES ON R&D

This section presents R&D programs for water quality management as initiated by DENR, particularly the Research and Development Division (RDD) of EMB, DOST, and the academe.

4.5.1 DENR R&D Initiatives

Some of the R&D programs for water quality management initiated by EMB-RDD are briefly discussed hereafter.

Studies and Research Endeavors. EMB has undertaken a number of different studies all aimed at improving the monitoring process and safeguarding of water bodies.

One such study is the Leachate Characterization Study, whose focal point was the study of leachate from various solid waste disposal facilities from 2005 to 2007. The assessments were performed with the goal of assessing the impacts of leachate on groundwater, with preference placed most heavily on parameters consistent with those included in the water quality criteria.

Another study, toxicity testing, is being conducted to determine the harmful effects of substances (toxicants) on test organisms. The testing is done following the Generic Protocol for Conducting Tropical Acute Toxicity Tests with Fish and Invertebrates, using identified toxicants such as mercury, arsenic, cyanide, cadmium, and nitrates, on a variety of test organisms, including milkfish (*Chanos chanos*) fry, bighead carp (*Aristichthys nobilis*) fry, and common carp (*Cyprinus carpio*) fry. The data being collected are useful in environmental criteria formulation, environmental quality assessment, and decision-making, all of which are beneficial in water quality monitoring.

A continuing challenge for EMB is the identification of additional indicators for pollution to arrive at more substantive analyses. In line with this, EMB initiated research efforts to identify and develop bioindicators for the assessment and protection of the aquatic environment. Aside from improving water quality assessment methods and techniques, characterization using biological indicators and indices are foreseen to serve useful/beneficial purposes as complement to the physico-chemical parameters commonly used in assessing or characterizing environmental quality.

Guidelines Development. Initiatives span the development of guidelines and regulatory instruments contributory to protection of Philippine water bodies. Among such guidelines are the sediment quality guidelines which aim to further protect marine and freshwater quality.

Initial efforts undertaken towards the development of sediment quality guidelines started with the preparation of the Report on Toxicity Tests for Freshwater and Marine Sediment Quality Guidelines Formulation in the Philippines. Another undertaking was the engagement of the Philippine Nuclear Research Institute to conduct sediment analysis using the Pb-210 method for sedimentation rate determination. The pilot study shall be conducted in coordination with the Manila Bay Office, and the study areas will be selected tributaries of Manila Bay. Sediment samples from the study sites will also be analyzed for metals and organics.

As a similar endeavor, the development of soil quality guidelines/criteria was initiated with the drafting of the National Soil Quality Status Report (NSQSR) in 2012, to protect groundwater quality as well as human health. Harmonization of analytical methodologies for soil analysis shall be undertaken. Soil quality criteria for industrial, commercial, recreational and residential purposes shall also be developed.

Monitoring Programs. EMB has established consistent monitoring programs in partnership with other agencies/institutions.

One notable program is the Green Fins Program, which is an internationally recognized project that aims to protect the marine environment, particularly coral reefs, through the promotion of a sustainable and responsible diving tourism industry and the upholding of a Code of Conduct. It was spearheaded by the United Nations Environment Programme-Cooperating Body on the Seas of East Asia (UNEP-COBSEA), with EMB being the Focal Point for UNEP-COBSEA in the Philippines. In support of this Program, EMB conducted monitoring of water quality in Balayan Bay from 2010 to 2012, which involved the sampling and monitoring of coastal water for physico-chemical parameters, particularly nutrients (nitrates and phosphorus), Fecal Coliform, and Total Coliform, to assess their suitability.

Also with UNEP-COBSEA was the COBSEA Yeosu Project on Coastal Erosion funded by the Korea International Cooperation Agency (KOICA). The aim of the project was to respond to policy and operational gaps in addressing threats and growing impacts of coastal erosion caused by sea-level rise. The National Assessment Report on Coastal Erosion was prepared and four project demonstration sites were proposed for pilot interventions, namely: Boracay, Aklan; Batangas City, Batangas; Bolinao, Pangasinan and Masinloc, Zambales.

On the other hand, the Land-based Pollution Study was conducted as follow-up activity in support to the UNEP-Global Environment Facility South China Sea Project entitled, "Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand". The project aimed to promote regional cooperation in the management and protection of the coastal and marine environment of the South China Sea, particularly the management of the different coastal habitats which are greatly challenged by pollution from land-based sources. To assess the contribution of pollution from land-based sources on the coastal and marine environment, water quality monitoring activities for metals and pesticides were conducted in the following WQMAs as pilot sites: the Balili River System (designated as WQMA through DAO 2013-05), and the Sinocalan-Dagupan River System (designated as WQMA through DAO No. 2011-14).

Similarly, a regular weekly monitoring of acid deposition is being conducted by EMB at the AGROMET-University of the Philippines, Los Baños, Laguna and Manila Observatory, Ateneo de Manila University Campus. These monitoring activities are conducted to generate data in support to the Acid Deposition Monitoring Network in East Asia (EANET). EANET also covers monitoring of soil and vegetation, as well as inland aquatic monitoring, to assess adverse impacts of acid deposition on terrestrial ecosystems and on inland aquatic environment, respectively. Water quality of Pandin Lake in San Pablo, Laguna, and the Ambulalakao Lake in Kabayan, Benguet are monitored. These monitoring data, together with the meteorological data observed in the vicinity, are then evaluated in order to assess the effect of acid deposition.

4.5.2 DOST R&D Initiatives

Grounded on RA 9275, DOST has established a National R&D Program for the prevention and control of water pollution. Spearheaded by the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD) of DOST, and in line with private and government entities, including the Presidential Coordinating Council on R&D, it has prepared a number of activities aimed at improving the water quality in the country. These activities have been united under a roadmap titled, "Science & Technology Water Environment Roadmap", which runs from 2011 to 2016 and is consistent with other existing plans such as the National Science and Technology Plan, Medium-Term Philippine Development Plan, and the 2015 Millennium Development Goals.

Programs implemented may be categorized into:

- **Water Technologies.** Studies for the technological improvement and/or treatment of water, particularly through filtration.
- **Wastewater Technologies.** Studies with the objective of effecting wastewater treatment and remediation through biological or artificial means.
- **Space Technology Applications on Water Resources.** Various space technology applications on water resources, such as the use of Light Detection and Ranging technology and photonics for aquatic resources assessment.

One program funded by the DOST Industrial Technology Development Division (DOST-ITDD) is the "Pasig River Stewardship Initiatives through Science and Technology Advocacy (U-Belt Consortium)". A follow-up to the project entitled, "Application of Sediment Quality Guidelines along the Tributaries of Pasig River", where metal contamination in the sediments from Pasig River tributaries has been identified. This project intended to provide technical support in the rehabilitation of the tributary *esteros* of the river, through concerted actions. Individual initiatives under this project are shown in Table 12. These were all conducted and completed in 2011.

Table 12. Individual Projects under DOST's Pasig River Stewardship Initiatives, CY 2011.

University/Agency	Study/Project	Project Description
FEATI University	Field Validation and Determination of Point Sources of Heavy Metals and PCB Contamination at Selected *Esteros*	Aimed to produce quantitative data on the contamination of sediments with heavy metals and PCBs present in selected *esteros*, and develop a Sediment Quality Guidelines to be used as baseline for rivers
Mapua Institute of Technology	Levels of Endocrine Disruptive Chemicals on Sediment Samples of *Estero de Pandacan*	Identified the different Endocrine Disruptive Chemicals in terms of xenoestrogen (phthalates, ethinylestradiol, and nonylphenol) present in sediment samples of one tributary (*Estero de Pandacan*) of the Pasig River
Adamson University	Biochemical and Mechanical Remediation Techniques for the Rehabilitation of *Estero de Balete*	Explored the application of bio-chemical and mechanical interventions on the remediation and rehabilitation of the water and sediment of *Estero de Balete.* Information on the effects of locally available natural materials on the treatment of *estero* water will provide concrete technical and methodical foundation for all efforts to rehabilitate Pasig River into a more balanced ecosystem by using natural minerals available in the Philippines, and provide an alternative to current technology which uses imported enzymes.
Centro Escolar University	Limnological Assessment of *Estero de Balete*	Compared the baseline data before and after the remediation treatment of the *estero* to determine the effectiveness of the pollution control strategies applied
Far Eastern University	Physicochemical and Biodiversity Study of *Estero de Paco*	Conducted an ecological study of *Estero de Paco,* investigated the physico-chemical and biological parameters of the *estero*, determined if there is significant variation of temporal and seasonal parameters, and assessed the extent of pollution and its effect on biodiversity
University of Sto. Tomas	Technological Management Practices of Multi-sectoral Stakeholders in *Estero de Paco*	Analyzed the interrelations of various stakeholders, their technology management patterns, and *estero* resource utilization to create a management model using an ecosystem approach
Integrated Program on Cleaner Production Technologies, DOST-ITDI	Instilling Environmental Awareness through Waste Minimization and Waste Management among the Learning Institutions and Communities	Provided learning institutions and communities with technical services, which include training module development, training delivery, and policy formulation, to promote Basic Environmental Management and enhance environmental awareness and responsibility

Source: DOST, 2013.

In addition to water and wastewater treatment technologies, other research and development programs on water resource assessment and management were also undertaken by academic institutions in coordination with the Emerging Technology Development Division of DOST-PCIEERD.

Philippine Light Detection and Ranging (LiDAR). This technology is a well-known mapping tool with the ability to spatially reference physical features at an extremely high accuracy for a large geographic area. Two projects using LiDAR were implemented by the University of the Philippines in Diliman:

- **Aquatic Resources Assessment using LiDAR.** A detailed map of the country's coastal resources was generated using aquatic features extracted from the LiDAR point cloud data. This includes a library of hyperspectral and multispectral images of mangroves, corals, seagrasses, macroalgae, and aquaculture-related facilities (e.g., fishpens and cages, fish).

- **Development of the Philippine Hydrologic Dataset for Watersheds using LiDAR.** This project aimed to assess the extent and state of all available water resources by compiling multi-level geographic data models for different hydrologic datasets into a single database. Applications include flood control planning, ground water monitoring, sedimentation, power generation, discharge and runoff studies.

Automated Rapid Reef Assessment (ARRAS) Program. A research conducted by the University of the Philippines in Diliman, ARRAS is a high-resolution imaging tool with the ability to perform fast classification and quantification of reef components such as color and texture features for pattern recognition of benthic classes (e.g., corals, seagrass, sand, and rubble). The program aims to develop a monitoring system that will allow coastal resource managers and LGUs to monitor their own reefs with easy-to-use tools. In addition, this rapid reef inspection system will provide direct validation of remote sensing algorithms for marine researchers.

4.5.3 Academe R&D Initiatives

Some of the independent research and development programs for water quality management initiated by academic institutions are briefly discussed hereafter.

Numerical Model to Estimate the Sediment Oxygen Demand (SOD) of the Pasig River (DLSU, 2009). This research focused on SOD, defined as the rate at which dissolved oxygen is removed from the water column in surface waters mainly due to the respiration of benthic organisms and decomposition of organic matter in the riverbed or bottom sediments. It showed that 30 to 90 percent of the total oxygen uptake in shallow and slow-moving waters was contributed by SOD.

In a slow-moving water body with high organic sediment levels such as the Pasig River, SOD can be a major cause for the constantly low DO level in the water column, particularly in the summer period. SOD data collected in this study can be one of the many input coefficients needed for water quality models that simulate the effect of an organic waste load on the river's DO level. SOD can be an additional criterion for evaluating surface water under RA 9275 and other water regulations like DAO 1990-34.

Application of Sediment Quality Guidelines along Tributaries of Pasig River by the U-Belt Consortium (2009). This project was led by the U-Belt Consortium together with the Industrial Technology Development Institute (ITDI) of DOST in cooperation with PRRC, MMDA, and ABS-CBN Foundation, Inc. The Consortium members include FEATI University, Adamson University, Arellano University, Centro Escolar University, Far Eastern University, Jose Rizal University, Lyceum of the Philippines, Manuel L. Quezon University, Mapua Institute of Technology, National University, University of the East, University of Manila, and University of Sto. Tomas.

This project assessed the sediment quality of *Estero de Sante Bañez* located in Brgy. Cristobal, Manila, which is one of the tributaries of Pasig River. Sediment samples were collected in its three sampling stations and analyzed for traces of heavy metals such as lead, copper, chromium, zinc, cadmium, nickel, and mercury. Analyses showed that there were variable distributions of the heavy metal content from the three sites of the estero.

Sampling activities for the drafting of sediment quality guidelines

Source: DOST, 2010.

Figure 34. DLSU Electrocoagulation System.

Source: DLSU, 2013.

Low Cost Wastewater Treatment Technologies. The development of decentralized, stand-alone, and low-cost wastewater treatment technologies has been studied by different groups to improve the sewerage and sanitation of the country. Several projects under this category are the following:

- **Development of Compact Electrocoagulation Reactor.** A research from DLSU in 2013, wherein the concept of material science and physical chemistry was applied to treat wastewater from the Pharmaceutical, Tannery, and Quick Service Restaurant sectors. The resulting technology is known as electrocoagulation that produces in-situ coagulants through electrochemical treatment process. While majority of electrocoagulation experiments conducted abroad were beaker tests, the research team designed and developed a bench scale reactor shown in Figure 34 that utilizes locally available aluminum and iron electrodes.

- **Utilization of Green Technologies.** A research from Ateneo de Manila University in which dried seaweeds (Sargasum sp. and Turbinariaornata) and water hyacinth were evaluated for potential sorption of metals. In these series of experiments, dried seaweeds were proven to absorb significant amounts of heavy metals such as lead, copper, mercury, and cadmium in wastewater samples. This biosorption process can be used as an alternative to recover heavy metals.

- **Utilization of Low-cost Alternative Wastewater Treatment (LOCAL WATCH) for Communities and Households.** The low-cost ferro-cement wastewater treatment is a decentralized anaerobic wastewater treatment system applicable for school and household clusters. This project aims to promote biogas digester for sanitation, waste management, water treatment, and the production of clean renewable energy.

Source: Ma. Elizabeth Morada

CHAPTER 5

BEST PRACTICES AND LESSONS LEARNED IN WATER QUALITY MANAGEMENT

Lamon Bay, Quezon

Source: Ma. Elizabeth Morada

This section presents the best practices and lessons learned in water quality management that could be adopted by others. This will not only encourage those who performed exceptionally, but will also allow others to replicate the documented best practices in water quality management.

INTER-AGENCY AND MULTI-SECTORAL APPROACH ON THE MANAGEMENT OF WATER BODIES

The significant contributions of certain water bodies warrant special attention for their proper management. Recognizing this, various agencies and sectors, such as government agencies, LGUs, industry stakeholders, local communities, NGOs, and academic institutions, have at times collaborated for the focused management of certain water bodies. Though at times promulgated by official issuances [for instance, EO 747 (Creation of the Cagayan River Basin Project Management Office) for Cagayan River of Region 2 or DAO 2013-01 for Tumaga River WQMA of Region 9], certain water bodies are given special attention based primarily on the initiative of stakeholders and other concerned entities.

The inter-agency and multi-sectoral alliances forged breeding grounds for the development and implementation of controls, rules, and regulations to prevent further degradation of the water bodies being focused on. Essentially, these partnerships allow individual or sectoral interests and short-term gains to be pushed aside to give way to long-term societal benefits.

Similar to the Adopt-an-*Estero*/Water Body Program, these inter-agency approaches allow the private sector to directly participate in the improvement of the country's environmental conditions. On a nationwide scale, this tradeoff maximizes mutual efficiency and greatly benefits both the government and private sectors as a whole.

PROVIDING REWARDS AND INCENTIVES TO IMPROVE ENVIRONMENTAL PERFORMANCE

One of the flagship programs of EMB, the PEPP has become the vehicle of DENR in enticing industries to comply with environmental regulations and to strive for enhanced environmental performance. The package of rewards and incentives such as the following have resulted to companies achieving desired environmental performance:

- Relaxation of reportorial requirements
  - o Frequency of submission
  - o Consolidation
- Simplified requirements for securing Environmental Compliance Certificate (ECC) for an expansion project
- High profile recognition award with DENR Official Seal of Approval

Applicants, whether as individual establishment or industry associations, undergo a rigorous assessment and evaluation process to ensure that they meet the following criteria:

- No case(s) filed with the PAB for three years prior to the date of application
- Full compliance with all applicable environmental laws, rules, and regulations
- Proven record of superior environmental performance

Some of the 32 companies awarded with DENR Seal of Approval have implemented effective water quality management programs that resulted to evident improvement of effluent quality and/or reduction in wastewater generation. Samples of these programs that are worth advocating are listed in Table 13.

Another support that PEPP provides is assistance to industries that have compliance issues but are nonetheless willing to comply with environmental regulations. Program support includes regulatory relaxation (subject to terms and conditions under an Environmental Consent Agreement), simplified requirements for ECC issuance, access to financial assistance from PEPP partner financial institutions, and access to technical/technology information through PEPP partners, among others.

DENR Seal of Approval

Source: PEPP, 2013.

INITIATIVES FROM LGUS, CIVIL SOCIETY, AND OTHER STAKEHOLDERS

Effective nationwide water quality management requires a multi-pronged approach from various sectors. While EMB is the lead agency designated for environmental quality protection, initiatives from other sectors are equally necessary considering the large scope of water quality monitoring activities and the financial constraints of the agency. For this reason, initiatives from stakeholders, being manifestations of the sectors' understanding and appreciation of proper water quality management, are welcomed. Throughout the Philippines, civil society initiatives have surfaced from various stakeholders such as LGUs (in the form of *Linis Bayan, Linis Estero*, and similarly-themed projects) and the academe (in the form of solid waste management programs, awareness campaigns, and information dissemination).

Table 13. Water Quality Management Programs Implemented and Their Corresponding Environmental Benefits.

Water Quality Management Program Implemented	Environmental Benefits
Effective operations of wastewater treatment plant coupled with effluent and sludge recovery	• Reduced volume of effluent discharge to receiving water body as a portion of the effluent is used for the maintenance of the facility's landscape and comfort rooms as well as inputs in the composting process of their solid wastes • Diversion of sludge from landfill as the dewatered sludge is processed and used as soil conditioner
Four-phased 3R's Program: 1. Reduce Fiber Loss at Source 2. Improve Efficiency of Effluent Treatment Plant 3. Recycle Usable Sludge as Fiber 4. Reuse Sludge as Fuel	• 97% reduction of BOD since the installation of the process • 100% solid wastes diverted from landfill after 2-year implementation (from 2007 to 2009)
Optimization of the biological wastewater treatment facility through the application of second generation sequencing batch reactor and reed bed system	Minimal discharge to receiving water body as treated effluent is utilized for soil fertilization in accordance with DA AO 2007-26

Source: PEPP, 2013.

Wastewater Treatment Technologies

Source: PEPP, 2013.

Stakeholder support also comes in the form of festivals (such as the Beachurero Festival of Region 8), and special clean-up days.

Considering the responsibility of every Filipino citizen to preserve and maintain the quality of our environment, it is both commendable and crucial for civil society and stakeholders to support the efforts of EMB in meeting and exceeding the requirements of our environmental laws. Public participation in active environmental protection is the key to preserving our waters for future generations.

INVESTMENTS IN SANITATION, SEWERAGE, AND WASTEWATER TREATMENT

Throughout the regions of the Philippines, notable investments in sanitation, sewerage, and wastewater treatment have surfaced. Extensive efforts in water remediation and related purposes ultimately lead to better water quality management, and in turn, improved quality of water bodies.

The urbanization and development of certain cities, such as Baguio, have considered large investments related to the sanitation and the centralization of sewage/sewerage systems. Similarly, in Region 2, a Small Water Impounding Project was initiated and implemented to control flooding situations and also to minimize soil erosion, a natural contributor to increases in TSS levels. Likewise, Regions 3 and 4B have invested heavily in the construction of an SpTP in Bulacan and a centralized STP in Puerto Galera, respectively, in order to better improve their management of septage and sewage. Moreover, Regions 4A and 11 have delved into the reduction of waste generation, and consequently, water pollution, through the construction and use of biomass-to-biogas conversion facilities.

The application and development of engineering controls and institutional controls serve a dual purpose: to guard against water pollution, and to abate already-ailing waters. Overall, in their efforts to achieve both, local governments are found commendable for setting aside a fraction of their budgets for water protection and rehabilitation.

R&D EFFORTS IN WATER QUALITY MANAGEMENT TECHNOLOGIES

In support of engineering projects involving the construction of facilities and infrastructure-related to water treatment and pollution prevention, EMB and other stakeholders have also invested in research and related efforts in an attempt to uncover new methods and technologies for improving water quality.

The standard procedure for emerging water remediation technologies is initial pilot testing on singular water bodies, assessment of feasibility, and upscaling for regional/national implementation. This was the adopted procedure for the tested water remediation technologies in *Estero de Paco* (NCR), which include a surface and island reactor; an electro-catalytic cell; surface aerators; waterfalls; aerobic baffled reactor; and interceptor box sewer, albeit no plans for upscaling have yet been identified.

Similarly, a prototype for the real-time water quality monitoring of Lepute River in Region 4A, utilizing Information Communication Technology-Enhanced Remote Sensing Protocols, was developed jointly by the LGU of Mataas na Kahoy, Batangas, and the regional offices of DENR, EMB, DOST, and DA. The technology is envisioned to assist in the monitoring of parameters for water bodies in the Region, and in turn, the water bodies in the country.

Researches involving natural approaches against water pollution, such as Region 12's use of Vetiver grass, are gaining popularity and are expected to pave the way for environmentally harmonic water quality improvements on a national level.

Rapid advancements in technology provide the country an opportunity to develop means to keep up with pollution rates. Based on the aforementioned research incursions, this is a fact the country already evidently recognizes and should continue to do so. EMB should be open to the adoption of emerging trends and technologies in its unending mission to preserve good water quality.

Source: Ma. Elizabeth Morada

CHAPTER 6

CHALLENGES

Daraitan (Tanay, Rizal)

Source: Ma. Elizabeth Morada

Since its enactment in 2004, RA 9275 or the Philippine CWA of 2004 has brought about significant improvement in the management and protection of our country's water resources. However, the implementation of the CWA is no easy feat, specifically for DENR and its partner agencies. While considerable progress on water quality management is evident, the Philippines is still faced with challenges in meeting its goal of providing clean water.

INVENTORY OF WATER BODIES

An inventory of the country's water bodies is necessary as this provides an overview on the availability of water resources in the country, and at the same time, highlights their various benefits, thus emphasizing the need to protect them. Currently, there is limited information on the total number of minor rivers, lakes, and coastal and marine waters in the Philippines.

Notably, an inventory of principal rivers is available, developed by NWRB in 1976. However, this inventory needs to be updated as well considering the geological transformations and administrative changes in the country. Admittedly, the complete inventory of water bodies cannot be accomplished immediately. But, a partial inventory can be achieved yearly; until eventually, all water bodies are accounted for.

CLASSIFICATION OF WATER BODIES

The classification of water bodies is essential as it defines the intended beneficial usages (e.g., public water supply, fishery, recreational activities) of waters. More importantly, the classification carries with it an associated set of water quality criteria established to protect its water quality and aquatic habitat as well as for it to maintain its beneficial usage. Hence, the classification of water bodies is necessary as it is a major leap in the protection and management of water quality.

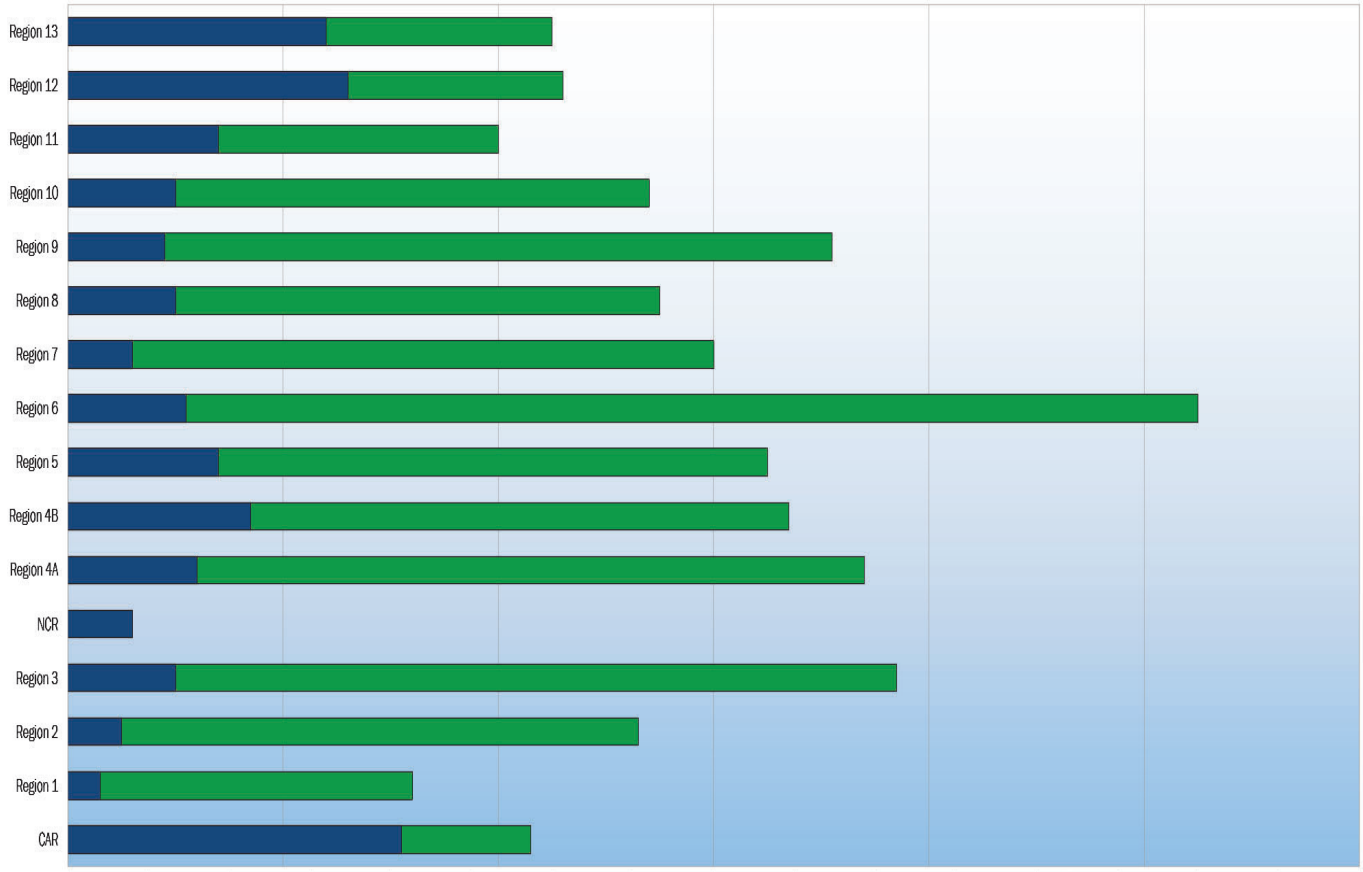
Likewise, the classification of water bodies is no easy task and requires time, manpower, funds, and other resources. A target number of water bodies for classification can be set yearly, until all inventoried water bodies are classified.

MONITORING OF WATER BODIES

The limited number of water bodies monitored by EMB is admittedly linked to the lack of sufficient resources to implement water quality management programs. Figure 35 presents the statistics on the monitored water bodies versus the total number of classified water bodies per Region.

Overall, 199 of 688 classified water bodies (29%) were monitored from 2006 to 2013 for regular monitoring and classification purposes. Except for NCR, the other 15 regions have several classified water bodies that are not being monitored. NCR has the least number of classified water bodies; hence, monitoring is more manageable as compared to the other regions. Furthermore, these statistics show the evident linkage between insufficient resources and the efficient implementation of water quality monitoring activities.

Figure 35. Percentage of Water Bodies Monitored per Region.



	CAR	Region 1	Region 2	Region 3	NCR	Region 4A	Region 4B	Region 5	Region 6	Region 7	Region 8	Region 9	Region 10	Region 11	Region 12	Region 13
Total Classified	43	32	53	77	6	74	67	65	105	60	55	71	54	40	46	45
Monitored	31	3	5	10	6	12	17	14	11	6	10	9	10	14	26	24
Percentage Monitored	72%	9%	9%	13%	100%	16%	25%	22%	10%	10%	18%	13%	19%	35%	57%	53%

Source: EMB, 2013.

Conduct of monitoring activities and availability of water quality monitoring data are vital in achieving the objectives of the CWA. Private sectors mandated through the CWA to conduct regular monitoring of their effluent's receiving water body should be strongly encouraged to comply with the requirements. In addition, efforts to obtain reliable statistical data based on seasonal averages (i.e., non-rainy and rainy periods), rather than annual averages, are needed to develop a more representative assessment of the quality of the country's water bodies throughout the year. Data from these monitoring activities can also be used to better augment EMB-initiated water quality monitoring activities.

PROVISION OF SUFFICIENT RESOURCES TO IMPLEMENT WATER QUALITY MANAGEMENT

Adequate water quality monitoring data and long-term monitoring programs are required to determine the extent of water quality degradation. Information is critical for decision-making at all levels.

However, current data collection on water quality and related social indicators are poor. Data gathering and analysis also tend to take place on an ad hoc basis.

The limited human power, together with the meager budget allocated, is a major constraint in the strict implementation of water quality laws and policies, specifically in monitoring activities. This highlights the need to enhance the country's resources in terms of manpower and financial capabilities.

Enhancements in resources are recommended such as the following:

- Human power to attend to various activities like permitting, monitoring, surveying, and implementing several water quality management programs
- Training and other capability building activities
- Water quality monitoring equipment to be used as back-up in case of equipment malfunction
- Laboratory equipment and supplies
- Global Positioning System and other advanced computer and software programs for database management

ASSESSMENT OF GROUNDWATER QUALITY

Groundwater resources in the country supply the water needs for most households (including drinking water), agricultural activities, and industrial processes, among others. Considering the dependence to groundwater of the country, its management is of paramount importance.

However, this remains to be a great challenge. There is an evident lack of groundwater resources map. This is very critical in determining potential sources of potable water as the water demand rises with the increasing population. In addition, there is incomplete data on water quality assessment of groundwater sources found in the country.

ENFORCEMENT OF WATER QUALITY REGULATIONS

Fast economic growth has resulted in rapid increase in population and urbanization. Accordingly, the increase in industrial and human activities impacts the quality of the country's water resources. To mitigate these impacts, the following strategies are recommended:

- Strengthen monitoring of small and medium establishments to encourage them to comply with water quality management regulations
- Formulate incentive schemes/strategies for well-performing establishments in terms of water quality management
- Heighten awareness and participation of LGUs and civil society regarding the water quality management and protection of waters and public health

ESTABLISHMENT OF SOIL EROSION CONTROL PROGRAMS

Sedimentation and siltation are recurring problems in many rivers. These are brought about by unsound agricultural and forestry practices, mismanagement of watersheds, and unregulated mining and quarrying activities of some small-scale miners. These are compounded by erratic flow patterns and persistent rainy periods, wherein huge loads of silt, soil, and debris runoff into river systems and receiving coastal waters.

Excessive amounts of silt and sediment not only deteriorate the quality of water sources vital to the social, environmental, and economic development of affected areas; but may also lead to flooding of low-lying regions as well as damage to infrastructure and agricultural farm lands. In addition, heavily sedimented rivers that provide critical supply of water to hydroelectric power plants may cause these silt and sediment to get stuck in equipment; thereby affecting their operating efficiency as well as the amount of electricity generated. To address these issues, there is a need to establish soil erosion control programs.

These include:

- Cleaning and desilting of rivers and channels
- Planting of trees and cover crops along riverbanks and areas prone to soil erosion
- Strict implementation of proper quarrying procedure
- Construction of a common settling pond or sedimentation basin for various mining operations to mitigate siltation of the river
- Prohibition of unsound agricultural farming and irrigation practices that tend to cause soil erosion
- Education of farmers on soil and water conservation
- Construction of groundsills and spur dikes
- Construction of flood control structures as well as utilization of environment-friendly technologies such as coconets and cocologs

CONTROL OF COLIFORM CONTAMINATION

The control of Fecal Coliform contamination is necessary especially for water bodies whose beneficial usages involve human interaction or are used for recreational activities such as swimming and skin diving. As discussed in Section 3 of this Report, 11 of the 19 monitored Class SB water bodies exhibited "Poor", with less than 50 percent compliance rating to the Fecal Coliform criterion. If left unaddressed, contaminated water bodies can affect communities and cause sicknesses such as gastroenteritis, diarrhea, and typhoid and paratyphoid fevers.

To address this issue, regulations that require commercial establishments, including beach resorts and hotels, to put up their own STPs or connect to an existing STP need to be strictly enforced to ensure the proper disposal of wastewater in concerned areas.

CONTROL OF MERCURY AND CYANIDE CONTAMINATION

Excess levels of mercury and cyanide were detected in rivers monitored near mining areas. Mercury and cyanide are frequently used to amalgamate and extract precious metals, whereas mercury is also used in gold processing plants as ball/rod mills. Mine tailings and untreated wastewater are then discharged into river systems and their tributaries, resulting in the deterioration of their water quality.

Once ingested, the concentration of mercury (specifically methylated mercury) biomagnifies from fish and other aquatic resources to up along the ecological food chain. Inhalation and prolonged exposure to mercury can also cause severe lung, gastrointestinal, and nervous system damage to the body. Cyanide, on the other hand, does not bioaccumulate in fish. However; cyanide poisoning through inhalation or oral exposure can lead to headaches, upper respiratory irritation, dyspnoea, convulsions, unconsciousness, and even death.

To rehabilitate the contaminated rivers, concerted efforts should be undertaken between LGUs and miners in the area. These efforts include:

- Relocating mining operators situated along riverbanks to a designated mining processing zone with a mine tailings disposal facility
- Desilting or desludging contaminated rivers
- Regulating mining operations and enforcing environmental mining standards in the area
- Prohibiting the use of mercury in small-scale mining and milling operations (as per DAO 2012-07)
- Developing alternative methods of gold recovery in coordination with DOST, MGB, and academic institutions

Gold panning

Source: larrycprice.com, 2013.

IMPROVEMENTS IN SEWERAGE AND SANITATION

Improper and inadequate sanitation and sewerage management contribute greatly to the pollution of receiving water bodies and nearby groundwater resources. Some areas have no centralized wastewater collection system, while others that have toilets do not desludge their septic tanks frequently. Thus, raw or untreated wastewater coming from residential, commercial, and industrial establishments is discharged directly into water bodies. Furthermore, some individual septic tanks are improperly constructed along riverbanks, with the overflow discharging to the nearby water body. To remedy these, the following actions are proposed:

- Inventory of sewage treatment systems to establish baseline on the number of households with access to proper sanitation as well as emphasize the need for proper management of sewerage
- Development and implementation of a centralized sewage treatment system

Residents along esteros

Source: philstar.com, 2013.

ENCROACHMENT OF INFORMAL SETTLEMENTS ALONG WATER BODIES

In most cities in the Philippines, informal settlers have established their communities along the banks of rivers, *esteros*, and creeks. Despite the success of current efforts to reduce the number of households along river banks, informal settlers remain to be a major pollution source in nearby water bodies. Relocation programs can be strengthened through the close coordination between government and private agencies. Information campaigns can also be organized to raise awareness on the impacts of informal settlement on the quality of water bodies. Moreover, provision of septic tanks and other sanitation infrastructure could serve as a temporary solution to reduce the disposal of wastes in water bodies, while relocation efforts have yet to be operationalized.

IMPLEMENTATION OF EFFECTIVE SOLID WASTE MANAGEMENT SYSTEM

The increasing Philippine population inevitably results into the generation of solid wastes not only from households, but also from commercial establishments such as malls, hotels, and restaurants.

For an effective implementation of solid waste management, all sectors of the society – from the government to the community – must share responsibility. Achievable waste management policies should be strictly enforced and non-observance of which should mean fees and penalties.

LGUs and national government should be able to find and develop market for recyclable materials to encourage adoption and implementation of recycling programs. Proper waste management should be perceived not only as social obligation, but also an economic opportunity.

Lastly, information campaigns should not be a sole responsibility of the government. Other partners and information venues should be developed, especially considering the very limited manpower and budgetary capability of the local and national government.

MITIGATING THE EFFECTS OF CLIMATE CHANGE ON WATER RESOURCES

Aside from rapid population growth, over-farming, massive deforestation, and mining; climate change is another major factor in the degradation of water resources in the country. Being a tropical nation, extreme climate conditions such as increased temperatures and changing rainfall patterns have led to heavy precipitation, intense tropical cyclones, and sea level rising, all of which not only have a direct impact on water quality, but also aggravate the effects of existing problems.

Although it is difficult to quantify the impacts of these climatic events, their implications on water quality are undeniable. A dramatic rise in temperature has already been linked to increased pollutant concentration as well as reduced DO levels and propagating algal blooms and fungi in water bodies, thus resulting to fish kills and incidents of red tide such as those mentioned in Section 3.5 of this Report.

On the other hand, heavy rainfall and stronger tropical typhoons lead to greater runoff and landslides; while rising sea levels result to saltwater intrusion into lakes, rivers, and groundwater reservoirs in coastal municipalities.

To prepare us for the effects of climate change on water resources, the following measures can be undertaken:

- Implementation, operationalization, and localization of the IWRM as a tool for climate change adaptation strategies
- Mapping of groundwater vulnerability
- Enhancement of database and information systems
- Construction of seawalls along coastal areas, dikes near flood-prone areas and buttresses in landslide-prone soil
- Conduct of IEC campaigns on climate change and its impact

SUSTAINING AWARENESS CAMPAIGN AND PUBLIC-PRIVATE PARTNERSHIP

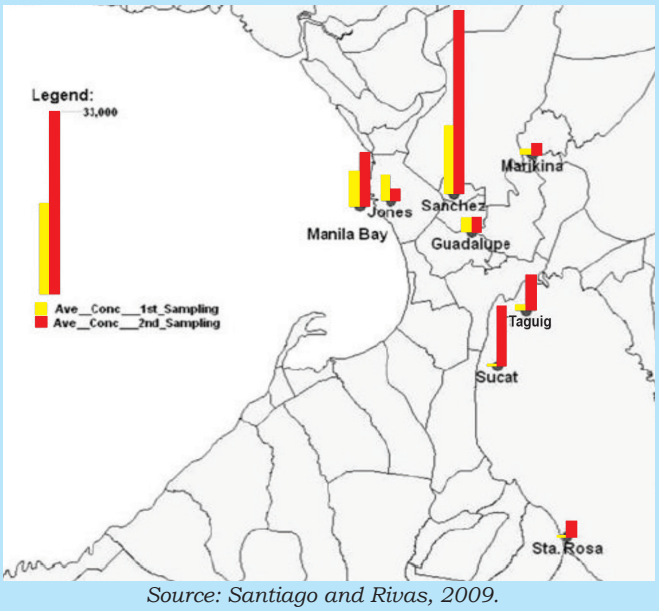
Massive information and advocacy campaigns on water conservation and protection are great challenges for increasing awareness and encouraging positive reception from the people.

The basic challenge of any environmental protection program mainly rests on the affirmative response of the community and sustained support of the public-private partnership. A continuing challenge is to maintain the programs that greatly contribute to this, such as the Adopt-an-*Estero*/Water Body Program and WQMA. A greater challenge lies in the continuing implementation of such management programs throughout the country, keeping cognizant of existing water management policies and programs so as to avoid overlaps.

Box 9. Effect of Typhoon Ondoy on the PCB Concentration of Pasig River.

A study to monitor the levels of PCBs in selected sites in Pasig River, Manila Bay, and Laguna Lake before and after a big flood was conducted in 2009. This was part of the United Nations University East Asia Regional Monitoring of the Coastal Hydrosphere Project implemented in the Philippines. The monitoring activity was focused on determining the levels of 16 specific congeners of PCBs in the selected sites for two sampling periods in August and November 2009. The results of monitoring showed that PCBs in the selected sites were significantly higher after the flooding brought about by Typhoon Ondoy.

The increase in PCB concentrations in the second sampling was attributed to the increase in contaminated sediments in the river sites and to the overflow of contaminated water in the lake sites; both of which could have been caused by the flooding event because of the typhoon.



Source: Santiago and Rivas, 2009.

The Philippines has made tremendous progress in conserving and managing its water resources since the enactment of the Philippine Clean Water Act in 2004. Through the leadership of DENR-EMB, the government issued a multitude of policies and regulations that not only helped define its water quality management framework and strategies, but also brought about significant progress in its overall water quality management.

A vital component to DENR-EMB's success is the involvement of partner agencies and stakeholders. From LGUs and industry sectors to NGOs, academic institutions, and civil society, the strong collaboration among these groups formed the cornerstone for the development and implementation of programs, projects, and activities geared towards resolving water-related issues. Over the years, their proactive participation served as a manifestation of society's growing realization on the importance of clean water in everyday life.

However, despite recent advancements, the sustained protection of the country's water resources is still faced with obstacles. The full enforcement of the Philippine Clean Water Act is impeded by the limited resources of DENR-EMB. Continual support from existing stakeholders as well as the forging of new alliances dedicated to the long-term benefits of environmental protection is therefore needed to expand the capabilities of DENR-EMB and ensure sustainable water quality management. Moreover, increased collaborative planning and investments to adopt best management practices are also required to prevent further degradation of water bodies in pollution-ridden areas.

With the foundation for sustainable water quality management already laid out, the main challenge now lies in the continuation of existing water quality management policies and programs to rehabilitate and preserve the quality of the country's water bodies, and ultimately, achieve and sustain quality life for future generations.

Pagbilao Bay
Source: Hazel Caasi

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Philippines at a Glance

GEOGRAPHY		
Land Area (in hectares, 2010)	34,334,832	
Boundaries	North – Balintang Channel South – Sulu and Celebes Sea	East – Pacific Ocean West – West Philippine Sea
Land Classification (in hectares, 2006)		
Alienable and Disposable Land	14,207,582	
Forest Land	15,792,418	
CLIMATE:Tropical; Normal average annual temperature of 27 degree Celsius; Two distinct seasons: Wet (June to Oct) and Dry (Nov to May)		
SOCIETY		
Population (2010)	92,337,852	
Population distribution (%, 2010)		
Urban	45.3	
Rural	54.7	
Population growth rate (%, 2010)	1.90	
Total No. of households, 2010	92,097,978	
Population density (persons/sq.km, 2010)	308	
Access to safe water (% population, 2011)	83	
Household with sanitary toilet (%, 2011)	79	
ECONOMY		
	2010	2012
Gross national product (million pesos) at current prices	9,003,480	10,564,886
Gross domestic product (million pesos) at current prices	5,701,539	6,311,670
Tourism: Visitor Arrivals (2013)	4,435,205	
Generated area of irrigation systems/projects (hectares)		
National	767,006	722,583
Communal	558,333	534,402
Crops Production (metric ton, MT):		
Palay	15,772,319	18,032,422
Corn	6,376,796	7,406,830
Sugarcane	17,929,269	26,395,893
Coconut	15,510,283	15,862,386
Banana	9,101,341	9,225,998
Fisheries Production (MT)		
Commercial	1,242,101	1,035,213
Aquaculture	2,545,967	2,541,965
Marine Municipal	1,184,137	1,083,495
Inland Municipal	187,252	197,422
Livestock/Poultry Production (MT)		
Carabao	148,020	142,730
Cattle	251,740	253,980
Hog	1,898,160	1,973,620
Goat	78,450	75,660
Chicken	1,353,130	1,479,440
Chicken Eggs	387,340	421,060
No. of Establishments by Industry Type (2011)		
Agriculture, Forestry and Fishing	5,124	
Mining andQuarrying	570	
Manufacturing	112,789	
Electricity; Gas Steam and Air Conditioning Supply	753	
Water Supply; Sewerage Waste Management	1,058	
Construction	2,994	
Trade and Retail (Vehicles)	384,031	
Transportation and Storage	6,248	
Food Service	105,208	
Information and Communication	19,630	
Financial and Insurance	28,742	
Real Estate	6,486	
Professional, Scientific, and Technical Activities	18,356	
Administrative and Supportive Service	19,118	
Education	15,227	
Human Health and Social Work	30,878	
Arts and Recreation	13,223	
Other Services	49,820	

Source: PSA (2012 to 2014), BFAR (2011), DOH (2011), DENR (2013), DOLE (2008), DTI (2011).

NATIONAL WATER QUALITY STATUS REPORT
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