

Chapter 12

Water Quality: Mindanao Island of the Philippines



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Abstract The Philippines is an archipelagic country dominated by water and inland water sources. Water quality has been the subject of attention for the country and specifically, Mindanao Island, because of the role this natural resource plays in agriculture. Water supply and usage for the island and the nation are identified and discussed in relation to the scarcity of potable water. Potential threats and pollution hotspots bring forth the various health and environmental impact attributed to the water system accessibility, distribution, and quality. Strategies addressing water resources problems are taken into consideration side-by-side the numerous national laws, policies, standards, and guidelines in addressing water quality control and management. Therefore, the legal framework for various agencies to carry out these policies on quality control, usage, and water management are pivotal to recommendations on revision of certain provisions that rely on embedding local community involvement to lessen the environmental impact that is causal to poor population health. The World Bank has been instrumental in prompting local activity with initiatives first established in relation to the United Nations Millennium Development Goals that are being carried forward today in the Sustainable Development Initiatives. This chapter extends the recent UN and World Bank initiatives to demonstrate how further community involvement can continue to improve quality of life for Philippine citizens through education and participation.

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12.1 Introduction and Background

Living on an island nation with multiple natural water resources did not guarantee access to clean water for the 75% of the Philippine population that has low socio-economic status and live in rural villages called barangays (United Nations 2017, *para 2*). However, global concern generated by the introduction of the United Nations (UN) Millennium Development Goals (MDGs) (United Nations 2015) and a steady flow of financial support from the World Bank at \$638.1 million (United Nations 2017, *para 7*; World Bank 2014) provides guidance and funding that led to the development of important national legislation and the enactment of institutions to respond to these and other community needs. Stronger institutions represent greater opportunities for citizen engagement through community-driven development (CDD) initiatives prompted by the UN. CDD is a platform for citizens to “make their own decisions in identifying, developing, implementing, and monitoring development initiatives based on their priorities” (United Nations 2017, *para 2*).

The progression of moving policy decision-making process from global initiatives to national initiatives began first with the UN establishing internal partnerships with existing Philippine government institutions, such as the Department of Social Welfare and Development and the National Statistical Coordination Board, providing community access and local monitoring. The UN also had external development partnerships, such as the Japan Social Development Social Fund and several governments, which were instrumental in developing important internal mechanisms and metrics based on monitoring the MDGS (United Nations 2017). These metrics establish empirical evidence for decision-making with the long-term goals of a healthy environment and population. “The monitoring of the MDGs taught us that data are an indispensable element of the development agenda,” and that “what gets measured gets done” (United Nations 2015, p.10).

Monitoring at the turn of the millennium quickly brought forth data indicating the leading water consumers, the problem of scarcity of water resources, and other threats to the availability of potable water that remains problematic in the nation. The baseline established the disproportionate use of agricultural consumption for irrigation and fisheries (Greenpeace 2007) accounting for 85.27% of the total water supply followed by the industrial sector (7.46%) and the remaining 7.27% for domestic consumption (World Bank 2004, p.29). Further, differentiating groundwater and piped-water supply systems sources was instrumental in revealing harmful practices in which groundwater extraction is done without permit. This indiscriminate and unregulated method of withdrawal led to the enactment of Executive Order No. 123 Series of 2012. The order mandates the transfer of National Water Resources Board (NWRB) from the Department of Public Works and Highways (DPWH) to the Office of the President then to the Department of Environment and Natural Resources’ (DENR) jurisdiction. Furthermore, the NWRB was tasked to immediately review the implementing rules and regulations of the Water Code of the Philippines (Barba 2004). These modifications to multiple water agencies and the introduction of new legislation were brought into action to regulate, monitor, and redistribute usage of water resources but distribution remains the same

Table 12.1 Total population served by different water service providers by region as of 2007 (Israel 2009)

Region	Water district	LGU ^a	RWSA ^b /BWSA ^c	Cooperatives	Total population served
Region 9 ^d	135,000	109,590	7208	510	252,308
Region 10 ^e	190,435	159,930	40,146	0	388,511
Region 11 ^f	285,596	47,932	28,586	27,151	389,265
Region 12 ^g	149,002	4842	0	0	153,844
ARMM ^h	123,455	35,740	0	0	159,195

^aLocal Government Units^bRural Water Supply Associations^cBarangay Water Supply Associations^dZamboanga Peninsula^eNorthern Mindanao^fDavao Region^gSoccsksargen^hAutonomous Region in Muslim Mindanao

today. Further, the water agencies struggle with interagency integration, manpower shortages, and lack of financial resource allocation at the local levels often rendering their mandated efforts ineffective (Rola et al. 2015).

The success of the UN MDG targets in the Philippines were evident meeting goals to improve access to drinking water up from 85% of the population in 1990 to 92% in 2010 (Fehr et al. 2013, p.638) but several challenges remain. Improved water sources (e.g., bottled, regulated water refilling stations) (Israel 2009; Madrazo 2002; Magtibay 2004; UNICEF and WHO 2012), an adequate freshwater supply and high rate of precipitation contributed to improvements (see Table 12.1). However, several factors such as biased geographic distribution, seasonal variations, and water shortages based on population distribution remain problematic (Barba 2004; Dumlao 2016; Ranada 2015). Damage to infrastructure due to civil unrest (Malapit et al. 2003) and the long history of the southern part of the Philippines being disenfranchised and underrepresented in the government is apparent in the lack of infrastructure projects there (Clausen 2010; Silva 2005) providing a historical basis leading to the present conditions. Furthermore, investments and policies crafted to better provide water access have been greatly affected by these conflicts (Clausen 2010). Earlier analysis of these political factors (e.g., institutional deficiencies, weak regulatory policies, lack of government leadership and political will, and lack of an integrated water resources management system) (Madrazo 2002) continue to pose additional barriers to the water crisis. Therefore, the legal framework on water quality, use and management are important factors for any proposed solutions.

The National Water Resources Board (NWRB) and Japan International Cooperation Agency (JICA) identified nine urbanized areas in the country, three of which are in Mindanao Island (Davao, Cagayan de Oro City, and Zamboanga City), facing water demand challenges in the next several years (JICA 1998). Health hazards associated with the shortage include an increasing number of gastrointestinal diseases caused by unpotable water and new housing developments that alter the balance of supply of and demand (Cortes-Maramba et al. 2006; Tacio 2014).

Consequently, these areas establish the basis for a growing concern for a national water crisis by 2025 (JICA 1998). Striking a national balance between the water supply and demand, especially in the areas limited by infrastructures and facilities, is vital to optimizing, producing, and distributing potable water.

This chapter unfolds the problem scope and legal framework for surface and ground water management, the important aspects of assessing water quality, and the health and environmental impact of contaminated water. Then, several water quality initiatives will be discussed followed by a series of recommendations promoting civic engagement to support local community involvement in government organized projects. The chapter concludes with a high-level summary.

12.2 Water Scarcity Problem Scope

The scope of water scarcity in the Philippines still rests on systemic problems brought forth at the onset of baselining the nation's status in relation to UN MDGs by the World Bank in 2003. Several major and tangential issues remain the foremost, of which access to clean water is important to population health. Ranked number 5 in the overall causes of death for the nation in 2010 analysis was preventable diarrhea attributed to unsanitary water at a rate of 354.5 per 100,000 population (DOH 2012, p.14). Therefore, the location of natural resources in the form of surface and groundwater provide geographic references demonstrating regional water availability and the problem location poses to access in areas of need.

Major issues concerning the use and scarcity of water include: (1) inconsistency of water supply and demand (Barba 2004; Madrazo 2002), (2) lack of water allocation system and distribution formula (Barba 2004), (3) NWRB weak regulation, permit monitoring, and enforcement of water use due to insufficient manpower and low operating budget (Barba 2004), (4) outdated principles mandated in the Water Code of the Philippines "first in time priority in right" and discretion is vaguely granted to a deputized government agency to investigate violations (Barba 2004, p.2), and (5) unsustainable water pricing that does not properly reward efficient water users with economic incentives (Barba 2004). Other threats to water availability are linked to (1) outdated research and framework plans, and (2) hampered policy decision-making due to insufficient data collection in certain areas, lack of data sharing protocols governing inter-agency access, and lack of a common integrated knowledge management database (Barba 2004).

Natural water-related disasters and environmental degradation are persistent threats to most of the watersheds in Mindanao impacting water access and quality. A super typhoon Bopha (Pablo) struck significant part of Mindanao in 2012 and super typhoon Sendong (Washi) in Cagayan de Oro caused watershed damage leading to high rates of erosion (Franta et al. 2016; Rodolfo et al. 2016). In 2015, the Butuan City Council approved the Resolution declaring a city-wide water crisis due to low water supply to 200,000 residents attributed to the damaged facilities and infrastructures of Butuan City Water District after onslaught of tropical storm Seniang.

Table 12.2 Water resource potential by region in Mindanao Island in million cubic meters (MCM) (World Bank 2003)

Region	Surface water	Groundwater	Total
Southwestern Mindanao	12,100	1082	13,182
Northern Mindanao	29,000	2116	31,116
Southeastern Mindanao	11,300	2375	13,675
Southern Mindanao	18,700	1758	20,458

However, investigation later revealed that the water crisis was a result of the neglect, callousness, and inefficiency of the officials of the local water district (Serrano 2015).

Man-made activities, such as deforestation or denudification, also spur on water-related disasters that degrade watersheds. DENR representatives cited three such watersheds due to the urgent need for rehabilitation from excessive deforestation (BusinessWorld 2011). Reducing nonrevenue water, the water that is lost from leaks, pilferage through illegal connections, and wastage, is another aspect in the problem scope of water scarcity.

While the problem of water scarcity spans several areas (e.g., policy, poor oversight, natural disasters, environmental degradation), there some are cases of emerging solutions. For example, Cagayan de Oro City and USAID partner to implement water-saving measures by reducing the percentage of nonrevenue water. The local water district of Cagayan de Oro estimates that they lose 53% (80,000 m³) of their water supply as nonrevenue water and aim to reduce to acceptable levels ranging from 20 to 30% (Jerusalem 2016). Upon completion of the project, water recovered in the process was slated to serve areas still lacking a water service connection.

12.2.1 Mindanao Water Source Potential

The water resources of the Philippines are composed of inland freshwater, coastal, bay, and oceanic water (Raymundo 2015). The portion of potential supply of water both surface and groundwater of Mindanao Island per region is shown in Table 12.2 demonstrating the uneven distribution of these resources that favor the Northern and Southern regions. Water resources differ also from province to province based on several factors like population density, rainfall patterns, watershed quality, and the rate of groundwater recharge (Senate Economic Planning Office 2011).

12.2.2 Mindanao Surface Water Resources

The Philippines have five principal river basins and two are found in Mindanao—the Agusan and Pulangi River Basins (Tan et al. 2012). The surface water resource of the nation is primarily the inland freshwater resources occupying 1830 km² of the

Philippine area (World Bank 2003) with an estimated 262 watersheds (Tan et al. 2012). Eight of the 18 significant rivers covering an area greater than 1000 km² are in Mindanao (World Bank 2003) which makes up watersheds or river basins that further drains into the bays in the north, east, and south.

12.2.3 Groundwater Resources

Mindanao houses two of the four major groundwater reservoirs in the Philippines, the Agusan Groundwater Reservoir (8500 ha) and Pulangi Groundwater Reservoir (estimated at 6000 ha). These groundwater resources lie beneath Mindanao's vast watersheds or recharging zones—the Agusan and Ligawasan Marshes (Tan et al. 2012) establishing Southeastern and Northern Mindanao as the highest potential groundwater resources (World Bank 2003).

A 5.3% annual increase in total demand for groundwater resources (e.g., domestic, industrial, and commercial) throughout the Philippines also saw a decline in precipitation reducing recharge by an average 3.7% annually and a steady decline in the volume of groundwater at an average annual rate of 1.4% from 1988 to 1994 (Philippine Statistics Authority 2016, *para* 4). This reveals that there is a continuing trend towards depletion of the country's groundwater resource stock making Mindanao Island, heavily reliant on the agricultural and industrial sectors for economic development, highly susceptible.

12.3 Legal Framework and Policies on Quality Control, Regulation on Water Usage, and Water Management

Understanding the existing national legal policy and framework on water use establishes important systemic factors in the existing protocols and presents an opportunity to apply analysis techniques to generate novel responses to the water scarcity problem. This section introduces government agencies, national laws, quality and emission standards, and presents problems associated with enforcement of existing guidelines.

12.3.1 Government Agencies

The water resources management of the Philippines is divided into several components performed by multiple government agencies and offices (Table 12.3) mandated by law and their charter, to perform roles in water supply, hydropower, irrigation, pollution, flood control, and watershed management (Dayrit 2001). The foremost agency in water management is the National Water Resources Board

Table 12.3 Philippine regulatory agencies and their primary enacted water resource function^a (Madrazo 2002; Dayrit 2001)

Agency	Function	URL
<i>Supply and water distribution</i>		
Department of Interior and Local Government (DILG)	Local government unit-run water supply, sewerage, and sanitation systems	http://dilg.gov.ph/
Department of Public Works and Highways (DPWH)	Flood control and drainage regulation	http://www.dpwh.gov.ph/dpwh/
Local Water Utilities Administration (LWUA) ^b	Local water districts managing water supply and sewerage systems	http://www.lwua.gov.ph/
<i>Policy formulation and planning</i>		
National Economic Development Authority (NEDA)	Highest socioeconomic planning agency and policy advisor to Congress and the Executive Branch	http://www.neda.gov.ph/
National Water Resources Board (NWRB)	Policy formulation, administration (water permits), and enforcement of the Water Code of the Philippines	http://nwrp.gov.ph/
<i>Water resource regulation</i>		
Department of Environment and Natural Resources (DENR)	Watershed regulation and quality; mandated to enforce environmental protection and pollution control regulations	http://www.denr.gov.ph/laws-and-policies.html
Department of Health (DOH)	Water sanitation, potability, and safety	http://www.doh.gov.ph/
<i>Other relevant regulatory agencies</i>		
Bureau of Soils and Water Management (BSWM)	Irrigation regulation	http://www.bswm.da.gov.ph/
National Power Corporation (NPC)	Hydropower regulation	http://www.napocor.gov.ph/
National Irrigation Administration (NIA)	Irrigation regulation	http://www.nia.gov.ph/

^aVarious local government units (LGUs) participate in each of the designated categories and are mandated to perform regulatory functions as stipulated in the Local Government Code of 1991 (Republic Act No. 7160)

^bAlso participates in Policy Formulation and Planning

(NWRB), responsible for policy formulation, administration, and enforcement of the Water Code of the Philippines (Madrazo 2002). The overlapping duties of the agencies and their regulatory framework can create a complex and competitive environment hindering effective water resource management.

12.3.2 National Water Use, Management Laws and Policies

The adoption of National Water Code of 1976 (Presidential Decree of 1067) is the first attempt by the national government to systematically manage the water resources of the Philippines. The main purposes of this policy are to (1) provide

basic principles and structural framework for the appropriation, control, conservation, and protection of water resources to achieve optimum development and efficient use to meet present and future needs; (2) determine the scope of the rights and obligations of water users and provide for the protection and regulation of such rights; and (3) the necessary and essential administrative machinery and systems. Several related laws and policies are enumerated below.

- *Republic Act No. 8041 or National Water Crisis Act of 1995.* Water supply, distribution, finance, privatization of state-run water facilities, conservation and protection of watersheds, and wastage and pilferage of water including the matters of graft and corruption in all water agencies.
- *Presidential Decree No. 198 or Provincial Water Utilities Act of 1973.* Mandates to create, operate, maintain, and expand local water districts (LWDs); direct and administer economically viable and sound provincial water supply and wastewater disposal systems.
- *Presidential Decree No. 1586 or Environmental Impact Statement System of 1978.* Mandates the administration of environmental impact assessment for all investments undertaken by the government of private sectors.
- *Presidential Decree No. 424 or Creation of National Water Resources Council.* Mandates the creation of a National Water Resources Council; primary duty of coordinating and regulating national water resource development; planning and policy for social and economic development.
- *Republic Act No. 7160 or Local Government Code of 1991.* Mandates the LGUs to enforce water-related laws and policies for sanitation, water supply, and flood control (Chan Robles Virtual Law Library 2015).

12.3.3 Water Quality Control Laws, Classification, and Assessment

The main document establishing and defining the basic regulatory programs (e.g., discharge standards, issuance of permits, monitoring of compliance) is the Philippine Environment Code (Presidential Decree No. 1151). Several national laws have also been passed and established defining policy on abatement, control, and water quality management. These laws are summarized below.

- *Republic Act No. 9275 or Clean Water Act of 2004.* Mandates the protection, preservation, and revival of the quality of the country's freshwater, brackish, and marine waters; pollution abatement; market-based instruments that charges fees based on effluent discharge volume impacting applications for permitting; and strengthens enforcement by imposing stiffer penalties for violations of standards.

- *Commonwealth Act 383 or Anti-Dumping Law of 1934*. Early legislation addressing environmental pollution (e.g., solid waste dumping) in rivers causing water levels to rise and/or streamflow blockage.
- *Presidential Decree No. 984 or Pollution Control Law of 1976*. Guideline for water pollution control water from industrial sources; establishes penalties for noncompliance and violation; requires industries to acquire necessary permits before operation.
- *Presidential Decree No. 856 or Sanitation Code of the Philippines*. Establishes the standards for collection and disposal of sewage, refuse, excreta covering both solid and liquid wastes; mandates cities and municipalities the responsibility to furnish efficient and proper waste disposal systems and to manage nuisance and offensive trades and occupations.
- *Republic Act No. 9003 or Ecological Solid Waste Management of 2000*. Mandates the systematic implementation of a national program that will govern the transfer, transport, processing, sorting, and disposal of the country's solid waste; establishes the criteria and standard for identifying landfill sites ensuring that their operation does not affect the groundwater sources in nearby aquifers.
- *Republic Act No. 6969 or Toxic Substances and Hazardous and Nuclear Wastes Control Act*. Establishes the standards in the control and management of the importation, manufacturing, processing, distribution, utilization, treatment, transportation, storage, and disposal of toxic, hazardous, and nuclear wastes and substances (Chan Robles Virtual Law Library 2015).
- *DENR Administrative Order No. 34 Series of 1990 or Revised Water Usage and Classification*. Establishes the categories and classification of water bodies in terms of their best usage; defines the minimum required for different water quality parameters per type of water classification.
- *DENR Administrative Order No. 35 Series of 1990 or Revised Effluent Regulations*. Stipulates the national standards for the discharge of effluents for the different classifications of water bodies.
- *DENR Administrative Order No. 26A Series of 1994 or Philippine National Standards for Drinking Water*. Establishes the national standard values for the different water quality parameters; guidelines and methodologies accepted for assessing the drinking water quality.
- *DENR Administrative Order No. 38 Series of 1997 or Chemical Control Order for Mercury and Mercury Compounds*. Establishes the policies on regulation and control of the importation, manufacturing, distribution, and use of mercury and mercury compounds; defines the accepted procedures on storage, transportation, and disposal of mercury and mercury compound wastes.
- *DENR Administrative Order No. 39 Series of 1997 or Chemical Control Order for Cyanide and Cyanide Compounds*. Establishes the requirements and procedures for importing, manufacturing, distributing, and using cyanide

Table 12.4 Number of classified inland surface waters and the classification criteria (Environment Management Bureau 2014)

Class	Beneficial use	Number in Class
AA	Public water supply class I. Intended primarily for waters having watersheds which are uninhabited and otherwise protected; require approved disinfection to meet the Philippine National Standards for Drinking Water (PNSDW)	5
A	Public water supply class II. For sources of water supply that will require complete treatment (e.g., coagulation, sedimentation, filtration, and disinfection) to meet the PNSDW	234
B	Recreational water class I. For primary contact recreation such as bathing, swimming, and skin diving. (particularly those designated for tourism purposes)	197
C	1. Fishery water for the propagation and growth of fish and other aquatic resources 2. Recreational water class II (e.g., boating) 3. Industrial water supply class I (for manufacturing processes after treatment)	333
D	1. For agriculture, irrigation, livestock watering. 2. Industrial water supply class II (e.g., cooling) 3. Other inland waters as determined by their quality belong to this classification	27

and cyanide compounds; determines protocol for the storage, transport, and waste disposal for these compounds.

- *DENR Administrative Order No. 58 Series of 1998 or Priority Chemical List/ DENR Administrative Order No. 27 Series of 2005 or Revised Priority Chemical List.* Determines the potentially harmful substances which pose unreasonable health risks to the public and even to the environment. The order requires companies, industries, distributors, importers, and manufacturers of chemicals listed to submit reports twice a year (DENR 2017; Chan Robles Virtual Law Library 2015).

Many of the water resource problems relate to quality rather than the quantity (Senate Economic Planning Office 2011) as water pollution affects island marine waters, fresh and groundwater sources. Surface water quality in the Philippines is classified in terms of its beneficial use (Table 12.4) and different portions of a water body can have several uses with multiple classifications. One example is the Lipadas River in Region 11 which has four classifications; Class AA upstream, Classes A and B midstream, and Class C downstream (EMB 2014). Notable is that two of the five Class AA inland waters can be found in Mindanao Region 11—the Lipadas River (upstream) and Baganga-Mahan-Ub (upstream).

Mindanao has 236 classified inland waters as of 2013 which were based on data monitored and collected by the EMB from 2006 to 2013 as shown in Table 12.5 (EMB 2013). Based on the data available, further efforts must be employed to

Table 12.5 Number of classified inland water of Mindanao per region (EMB 2013)

Region	Class AA	Class A	Class B	Class C	Class D
Region 9 ^a	0	32	33	6	0
Region 10 ^b	0	40	1	11	0
Region 11 ^c	2	9	12	10	3
Region 12 ^d	0	9	13	15	5
Caraga ^e	0	11	1	12	9
ARMM ^f	0	0	0	2	0
TOTAL	2	101	60	56	17

^aZamboanga Peninsula^bNorthern Mindanao^cDavao Region^dSoccsksargen^eCaraga Administrative Region^fAutonomous Region in Muslim Mindanao

classify the remaining inland waters to provide additional information and for further management and rehabilitation if needed, especially in the case of Autonomous Region in Muslim Mindanao (ARMM).

The assessment of water quality is based on the number of samples taken from the body of water meeting the DAO 1990–34 water quality criteria per parameter (EMB 2014, p.9). Only bodies of water with at least four sampling events, representing both the dry and wet seasons, were included (EMB 2014). Please refer to the EMB (2014) for details on assessment methodologies used to rate water bodies for optimum levels of various particulate matter based on DENR formulations of ambient standards. DENR standards emphasize parameters such as dissolved oxygen (DO), biological oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), and heavy metals to assess inland water quality. The standard value in each parameter serves as the benchmark data for monitoring and assessing water quality in their respective classification.

12.3.3.1 Dissolved Oxygen

Dissolved oxygen (DO) is a parameter used to indicate level of water pollution and the capacity to support aquatic plants and animal life (Greenpeace 2007). Water movement, temperature, and pollution can also affect the concentration of DO in a body of water. High levels of DO are observed in water bodies with these activities.

Only 138/164 (84%) of the inland waters monitored by the EMB met the required sampling events from 2006 to 2013 while 81/138 (59%) were deemed to have “good” water quality (EMB 2014, p.9). Most of these are Class A or C designated bodies of water located in Regions 10, 12, and 13 of Mindanao (EMB 2014).

12.3.3.2 Biological Oxygen Demand

Biological oxygen demand (BOD) is a measure of the amount of oxygen consumed by microorganisms in decomposing organic matter from a pollution source (EMB 2014). Higher levels of BOD manifest downstream where decomposition occurs and not where the effluent is directly discharged (EMB 2014).

Only 75/131 (57%) if the inland waters that met the sampling requirements are considered “good” (EMB 2014, p.11). They were from Class A or Class C water bodies in Cordillera Administrative Region (CAR) and in Regions 10, 12, and 13 of Mindanao.

12.3.3.3 Total Suspended Solids

Total suspended solid (TSS) is a measure of undissolved solid in water (e.g., silt, decaying plant and animal matter, domestic and industrial wastes) (EMB 2014). A body of water with high TSS value has lower capability of supporting aquatic life due to reduction of the light penetrating the body of water.

Only 40/138 (29%) Class AA and Class A water bodies met the sampling requirements while only 13/40 (33%) bodies of water manifested “good” quality (EMB 2014, p.12). Two out these water bodies were just shy of reaching 100% compliance rating—(1) Mindanao, upper portion of Taguibo River (99%), and (2) Lake Mainit (98%) (EMB 2014, p.12). Several water bodies from Mindanao received a “poor” rating including the Davao River (upper reach) in Region 11, Lun Masla River in Region 12, and Iponan River in Region 10.

12.3.3.4 Total Dissolved Solids

Total dissolved solids (TDS) refers to a broad array of chemical contaminants coming from agricultural runoff, leaching soil contamination, and point source pollution from industrial or domestic sewage (EMB 2014).

Only 17 (55%) bodies of water manifested “good” quality out of 30 Class AA/A bodies of water monitored which are mostly concentrated in Region 3 and only Marilao River in Bulacan had a “poor” quality level (Greenpeace 2007, p.16).

12.3.3.5 Heavy Metals

Heavy metal ions are soluble in water that forms toxic sediments at the bottom of bodies of water. These are considered harmful to aquatic life and to humans who consume seafood contaminated with high concentrations of heavy metals. Monitoring heavy metals is important to maintaining healthy waterways especially in water bodies that are near mining industries, electroplating, tanning, and other similar activities (Appleton et al. 1999; Baharom and Ishak 2015; Canencia et al. 2016).

Additional findings in the EMB report include results from 63 inland surface water bodies that were monitored in terms of total mercury, cadmium, and lead from

2006 to 2013. These monitored rivers exhibited 100% total mercury compliance except for Agno, Malaguit, Panique, and Tubay Rivers (Mindanao) (EMB 2014, p.16). Tubay River (Class A) did not meet the criterion in two sampling events out of 56 conducted. However, the presence of mercury there could remove the Tubay River as potential source of potable water.

Similarly, the maximum limit of cadmium was present in 10/18 bodies of monitored waters from 2006 to 2013. Of these ten, the lower part of the Davao River (Class B) is found in Mindanao. Although this river did not completely meet the compliance standard, notable is that of the ten rivers, the Davao River exhibited the highest compliance rating with 93% (EMB 2014, p.17).

Lead monitoring indicates that only 7/18 bodies of water monitored met the maximum limit demonstrating a 100% compliance rating. The Davao River in Mindanao, both upper and lower sections did not meet the maximum limit and both sections failed some aspect of sampling collection event (EMB 2014, p.18). These findings are particularly alarming for the upper section of Davao River, because of the Class A designation as a source of potable water.

12.3.4 Standards Overview: Ambient Water Quality, Wastewater Emission, and Enforcement

Various Philippine legislations cover different water quality parameters. This section provides an overview of major evaluation protocol for surface water, groundwater used to produce drinking water, bottled water, and wastewater. Then we present some high-level issues of enforcement relating to these standards.

12.3.4.1 Ambient Water Quality

Ambient water (e.g., lakes, rivers, oceans) quality is defined as the average water purity distinguished from discharge measurements taken at the source of the pollution as defined by the Clean Water Act of the Philippines (Greenpeace 2007). DENR Administrative Order No. 34 Series of 1990 sets forth 33 water quality assessment for minimum and desired levels for drinking water, water purification, polyvinyl chloride, and bacteria. Five key parameters determine classification and reclassification of surface water bodies: (1) pH, dissolved oxygen (DO), biological oxygen demand (BOD), and total coliforms.

12.3.4.2 Drinking Water

For drinking water, the Philippine National Standards for Drinking Water (DOH 2007) holds criteria for bacteriological, physical, chemical, radiological, and biological qualities across 56 parameters used to assess groundwater source quality.

Only three measures—fecal coliform, salinity or chloride content, and nitrates (EMB 2014) are highly relevant. Chloride and nitrates constitutes the total dissolved solids (TDS) with a maximum limit of 500 mg/L while no total coliform must be detectable in 100 mL sample for the fecal coliform parameter (World Bank 2003).

12.3.4.3 Bottled Water

Standards for bottled water are stipulated in Bureau of Food and Drugs (BFAD) Administrative Order No. 18-A Series of 1996. The BFAD stipulates assessment of several parameters including the levels of bacteria, viruses, parasites, fertilizers, pesticides, hydrocarbons, detergents, phenolic compounds, heavy metals, radioactive substances, and other soluble organic and inorganic substances. Source quality, production processes and facilities, and handling and proper labeling are also part of the BFAD order.

12.3.4.4 Wastewater

The protocol for wastewater effluent emission standards are gathered in DENR Administrative Order No. 34 and 35 Series of 1990 as they apply to the different classifications of water bodies. Several standards dictate maximum corresponding numerical values coming from any point source for any effluent discharge but target toxic and deleterious substances which can affect the quality of the receiving body of water. Discharge of effluents in bodies of water categorized as Class AA is strongly prohibited to ensure protection of public health while for other categories, industrial discharges and effluents should not contain toxic substances greater than the indicated value in the said order (Greenpeace 2007). Standard values on conventional and other pollutants which affect the aesthetic and oxygen demand are also established in these administrative orders. Some researchers have suggested that despite the number of governing policies, standards, and guidance, these assessment parameters appear to be relatively insensitive to the actual ambient standards due the utilization of concentration-based standards (Luken 1999).

Current wastewater standards do not reflect the proliferation of toxic chemicals used for and as a byproduct of modern industrial and commercial processes especially in electronics and semiconductor industry, such as beryllium, nickel, copper, tin, zinc, vanadium, and many other volatile organic compounds (VOCs).

12.3.4.5 Enforcement

Enforcement of existing laws and regulations are another prominent issue. Several researchers have identified the problematic nature of government institutions due to inefficient and/or ineffective activities. For example, overlapping, or in some cases

competing, water resource management function and enacted responsibilities across various levels of government challenging leaders to agency realignment (Rola et al. 2015). Because of this problem of variance in policy and implementation mechanisms, consistent enforcement remains a challenge for the national and local governments (USAID and AECEN 2004). The problem becomes transparent when a new law is enacted but then adopts a new or different strategy, giving varied powers and responsibilities to existing government agencies like the EMB, LGUs, and other especially constituted multisectoral management and regulatory bodies.

Several challenges in the enforcement of existing regulations, such as an unclear reporting structure, accountability, enforcement responsibilities, and nonstandardized inspection procedures, have been identified by the EMB (2014). The EMB faces their own challenges in reporting structure as staff in the provincial and community offices are categorized as reassigned personnel reporting to the DENR regional offices and not directly to the EMB hierarchy as prescribed by the EMB mandate. Additionally, these EMB personnel are in the DENR Regional offices and depend on their resources. This crease results in the delay of submissions of reports, determination of accountable personnel, and mandate enforcement.

Another prevailing enforcement issue is that most local government officials are unaware of their responsibilities with regards to the enforcement of the Ecological Solid Waste Management Act and other pertinent policies. Most of the responsibilities and obligations LGU require significant technical capability aside from financial investments. However, training conducted by the DENR and internal training conducted by the LGU do not reflect this. While a good strategy to address this challenge is for the DENR to facilitate compliance of LGUs through capacity building activities, workshops, and penalties exacted on LGU officials that violate or fail to meet their mandated responsibilities, DENR budgets do not currently allocate for training or monitoring of LGUs. EMB annual budgets for training, monitoring and inspection are annually exceeded and do not receive a steady revenue source. This creates a challenge of allocating enough budget for the DENR to be able to provide a comprehensive program for capacity building to prepare LGUs for the enforcement of certain provisions of the law.

Another enforcement problem is the lack of cohesive, standardized procedures in various EMB field offices. Instead, field agents often establish and practice their own procedural strategy when conducting inspection and monitoring tasks. Although several attempts have been made to produce unofficial field guides, manuals, and checklists for the standard conduct of inspection, these items were unsuccessful. First, they were considered impractical to actual field situations, and second, they failed to garner support because they were not backed by official administrative orders reinforcing their implementation.

Demand to address certain limitations of current and existing laws, standards for water quality and effluents, and enforcement is apparent. While policies are presumably adequate, agencies face limitations on enforcement that may only be ameliorated by institutional influence.

12.3.5 Groundwater Quality Assessment

The country's groundwater resources provide most of the water needs for households, agricultural activities, commercial, industrial processes, and others. Therefore, preventing groundwater contamination and remediating contaminated groundwater are important considerations that warrant testing and other associated expenses.

In assessing the country's groundwater quality, the Philippine National Standard for Drinking Water (PNSDW) is referenced. This standard includes relevant parameters indicating the level and degree of pollutants such as fecal coliform and nitrates. Other common parameters (e.g., salinity, chloride content) are used to indicate the level of seawater intrusion.

12.3.5.1 Fecal Coliform

The PNSDW prescribes that drinking water should contain less than 1.1 Most Probable Number per 100 mL (MPN/100 mL) using the method of Multiple Tube Fermentation Technique (EMB 2014). The EMB conducted a program in 2008 to consolidate the results of analyses on tap water samples for Total and Fecal Coliforms submitted by different regional laboratories across the country. Under this program, 59 shallow wells were monitored in selected areas of the country and 6 were found to be potable, 23 failed to meet the fecal coliform standard, and the remaining 30 sites require further testing (EMB 2014). Sites found not potable in Mindanao are in Zamboanga City and Davao City (Greenpeace 2007).

12.3.5.2 Nitrates

Environmental nitrates are found in the salts of ammonium, sodium, potassium, and calcium from soil fertilizers during agricultural runoff, wastewater treatment, confined animal facilities, and from sewage discharge of septic systems (EMB 2014). No major study has been conducted to determine the nitrate levels of various groundwater sources in Mindanao except in the agricultural regions of Northern and Central Luzon (Tirado 2007).

12.3.5.3 Salinity or Chloride Content

Excessive withdrawal of groundwater causes the natural groundwater gradient to reverse and allow seawater to contaminate and intrude the aquifers in coastal areas (Pinder 1981). Seawater intrusion can affect the potability of drinking water and the quality of water in irrigation wells leaving some areas unfit for continued agricultural activities (EMB 2014).

Table 12.6 Standard rates for evaluation of groundwater and surface water quality (World Bank 2003)

Parameter	Satisfactory	Marginal	Unsatisfactory
DO (mg/L) ^a	>5	5	<5
BOD (mg/L) ^b	<5	5	>5
TDS ^c	Less than 10% of wells tested did not meet standard	N/A	10% or more of wells tested did not meet standard
Coliform	No wells found positive for coliform (0%)	N/A	Wells found positive for coliform (>0%)

^aDissolved oxygen^bBiological oxygen demand^cTotal dissolved solids

No current study assessing the degree of seawater intrusion in the groundwater resources of Mindanao Island to date. However, some studies were conducted in the areas of Luzon (Insigne and Kim 2010) and Visayas (Scholze et al. 2002).

12.3.5.4 Pollution Hotspots

The Philippine Government maintains the quality of water bodies according to intended and beneficial use (DENR 1990). In 2003, pollution hotspots of surface water were assessed by the World Bank and evaluated by province using DO and BOD criteria while groundwater sources tested TDS and coliform. Water quality status of surface waters was categorized and rated as Satisfactory (S), Marginal (M), and Unsatisfactory (U) while groundwater quality status was rated either Satisfactory (S) or Unsatisfactory (U) (Table 12.6).

Results of the 3-year monitoring project conducted by the World Bank reported on the Water Quality Scorecard for Surface Waters from Regions 9–11 and 13 are satisfactory with marginal ratings for the Mercedes River (Region 9), Manicahan River (Region 9) and Agusan River (Region 13) (World Bank 2003, p.36). Several surface water bodies on the island were rated as unsatisfactory including the Saaz River (Region 9) and the Padada, Tuganay, and Agusan Rivers in Region 11 (World Bank 2003, p.36). There were no available data for Region 12 and ARMM.

There were further gaps in analysis. No groundwater data were available for Regions 12, 13, and ARMM for both TDS and coliform while for Region 9 and 11, no coliform data were available (World Bank 2003). Zamboanga del Sur (Region 9) and Misamis Oriental (Region 10) groundwater sources were rated unsatisfactory for TDS while Misamis Oriental (Region 10) was rated unsatisfactory for coliform (World Bank 2003, p.37).

12.3.5.5 Point and Nonpoint Sources

Water pollution can be classified in terms of its source—(1) point source pollution, and (2) nonpoint source pollution. Point source pollution refers to any pollution with an identifiable pollution source with a specific and known discharge point. On the other hand, nonpoint source pollution refers to pollution with no known or identifiable source (World Bank 2003).

Point source pollution can be categorized into three main sources—domestic wastewater discharges, agricultural wastewater discharges, and industrial wastewater discharges. Pollution load is calculated using BOD as the measuring parameter indicating pollution contribution from point sources is 24% from Industrial discharges, 31% from Domestic or Municipal discharges, and 45% from Agricultural discharges (EMB 2014, p.24) The calculations for domestic, agricultural, and industrial BOD can be seen in the documents published by World Bank (2003), EMB (2014), Economopoulos (1993).

Domestic discharges contain the most organic waste with suspended solids and coliforms from common household and kitchen activities (World Bank 2003). The problem is attributed to the lack of appropriate domestic sewage treatment system allowing allows 90% of inadequately treated domestic sewage discharged into surface waters (Greenpeace 2007, p.19). Major areas that generate BOD are Metro Manila and Region 4A (18% and 15%, respectively) while only small levels of BOD are generated in Mindanao regions (World Bank 2003, p.7). In Mindanao, regions 10, 11, and 12 went above the 50 thousand megaton mark for BOD load while areas within regions of 9, 13 and ARMM were below 50 thousand megaton marks (World Bank 2003).

In terms of agricultural BOD, Regions 4 and 1 contributed the most BOD in the country (13% and 12%, respectively). In Mindanao, region 10 is ranked fourth in BOD attributed to active animal and vegetable farming in this region, while Region 13 and ARMM (1.2% and 3.0%, respectively) had the least agricultural BOD contribution (World Bank 2003, p.21). Notable is that Region 13 also has the least agricultural BOD contribution for the whole country.

Industrial BOD contribution depends on the volume and characteristics of industrial effluents which vary by industry type. Water-intensive industries discharge huge amounts of waste water (Canencia and Walag 2016; World Bank 2003). Most of the water-intensive industries are in Luzon in the National Capital Region, Regions 3 and 4, thus having the most BOD contribution (42.5%, 9.0%, and 14.1%, respectively) while other regions, such as 11 (6.6%), 9 (3.3%), 10 (2.2%), and 8 (1.1%), have relatively smaller contributions. Finally, ARMM reports 0% BOD contribution due the absence of or an insignificant number of large industries (World Bank 2003, p.21).

Nonpoint source pollution depends generally on the land use thus it is calculated and estimated based on the different land uses. Several technologies are now available to help monitor, control, and mitigate the effects of point source pollutions but there remains difficulty in these activities for nonpoint sources (Greenpeace 2007). The difficulty in monitoring is evident in the lack of information and scarcity of monitoring on the contribution of solid waste, a major source of nonpoint pollutants (World Bank 2003).

12.4 Health and Environmental Impact

Human population and the surrounding environment are at risk when bodies of water like rivers, streams, and lakes are polluted with wastewater or spillage. These source bodies of water, in turn, contaminate nearby groundwater making humans susceptible to environmentally-related illness and disease resulting in mortality and morbidity (Cabral 2010; Grimes et al. 2015). Specifically, inadequate sanitation and hygiene brought about by lack of clean, safe, and comfortable facilities could promote the risk of acquiring diarrhea (Pfadenhauer and Rehfuess 2015) “which is second to pneumonia as the leading cause of morbidity in the Philippines” (DOH 2012, p.63) in diseases related to the environment. Several studies discussed in this section have firmly established the relationship between polluted water supply and disease in the Philippines (WEPA n.d., para 7):

Untreated wastewater... makes water unfit for drinking and recreational use, threatens biodiversity, and deteriorates overall quality of life. Known diseases caused by poor water include gastro-enteritis, diarrhea, typhoid, cholera, dysentery, hepatitis, and more recently, severe acute respiratory syndrome (SARS).

Water bodies in urban areas are the most susceptible to contamination due to the direct and indirect pollution caused by unprecedented development. However, rural surface waters are endangered due to farming, animal production, and other food sector industries that release organic pollutants into the water system. Consequently, the environmental impact of improper sewerage leading to unsanitary water causes a variety of debilitating health effects on living creatures—land-dwelling animals, aquatic life and humans.

12.4.1 Water Supply Contamination and Diseases in Humans

Excessive levels of fecal coliform organism and *E. coli* indicative of surface water contamination was detected in a recent study of Cagayan de Oro River upstream. The contamination was attributed to improper disposal of animal wastes, human wastes which are discarded directly to the river, and poor sewerage in nearby communities (Lubos et al. 2013; Lubos and Japos 2010).

Several studies confirm the need for increasing attention to watershed management and sanitation. The Labo and Clarin Rivers are considered important to the different communities in Misamis Occidental, where both tested positive for coliforms; the site along the agroforest and agricultural areas had the highest total coliform (Labajo-Villantes and Nuneza 2014) confirming the need for increasing attention to watershed management. Several problematic physicochemical and bacteriological qualities were also reported in several rivers—the Aligodon, Misamis Oriental, Daveo River, and Talomo (Ido 2016; Laud et al. 2016).

Morbidity from outbreaks of diarrhea continue to be a major health problem stemming from groundwater contamination of wells on farmland in villages in

North Cotabato (Pelone 2014a) and the application of herbicides on cornfields that are washed down to river systems (Bacongco 2014). One death and 32 instances of mortality was consequent to contamination through leakage of distribution pipes in Zamboanga City (Pelone 2014b) where 14/19 residents there later tested positive for norovirus (Radyo Natin 2016).

12.4.2 Fish Kills and Red Tide Occurrences

Low DO levels in water, abrupt and abnormal shifting water temperature, and deteriorating water quality are common environmental conditions that kill aquatic life (EMB 2014). Several fish kills were documented and recorded throughout the island including the 1 km long algal bloom of *Cochlodinium* sp. in the coastal area Jasaan, Misamis Oriental in 2003 (Jabatan 2004). The bloom occurs because of high surface temperature, favorable transport, radiation available for photosynthesis, and enrichment for organic nutrients (Kim et al. 2016; Lee and Choi 2009; Tomas and Smaydab 2008).

Several fish kills were reported in the island to have been caused by oxygen depletion due to overcrowding and harmful algal blooms Lake Sebu and Lake Seloton in South Cotabato and Iligan bay (Fernandez 2017; Vicente et al. 2002). Consequently, government representatives of Maguindanao took precautionary measures to ensure the balance of environment and marine life in the Lake Buluan by regulating the number of fish pens (Sarmiento 2017).

The health of humans and marine species are both continuously threatened by occurrences of Red Tide. Mindanao's affinity for red tides, shown on the data from the Incidences of Red Tide in Coastal Areas in 2016, has been credited to northeast monsoon-driven upwellings (EMB 2014). Balite Bay in Mati, Davao Oriental was exposed to red tide from January to March 2016, posing significant threats to aquatic life until finally deemed toxin free in early March (Bureau of Fish and Aquatic Resources 2016).

12.4.3 Improper Sewerage and Sanitation

In the Philippines, 76.8% of families have sanitary toilet facilities but only less than 10% are connected to piped sewerage system while the rest rely on septic tanks, pit latrines, or open defecation (EMB 2014, p.28). Both the existence of unsuitable sewerage systems or absence thereof greatly impacts the quality of different bodies of water because this type of contamination may give rise to various water-borne diseases caused by various microorganisms (EMB 2014).

While incidents of diarrhea have been deadly several other viral infections can result from unsanitary water. Instances of hepatitis in Surigao del Sur (Crisostomo and Serrano 2006) and leptospirosis in Davao City (Zapanta et al. 2014) were all

attributed to poor sanitation and improperly maintained sewage system. Rural areas are typically affected where water systems, such as traditional wells and rivers, contain fecal matter that contaminates the source (Bain et al. 2014).

12.4.4 Mine Tailing Spillages and Siltation

Several activities and sources of mercury and heavy metals that pollute water bodies can be attributed to mercury mining, gold mining, chemical industry, metal smelting, coal combustion, and metropolitan and agricultural runoffs (Li et al. 2009). Several mining industries are in the eastern and western sections of Mindanao where reports of spillages, heavy metal pollution, and siltation of nearby bodies of water have taken place (Appleton et al. 1999; Cortes-Maramba et al. 2006).

The gold mining industry has a strong presence in Eastern Mindanao near the Agusan River where the gold-rush town of Diwalwal has a foothold. Initial analysis revealed that the Diwalwal drainage, evident downstream of the river system, was characterized by extremely high levels of mercury in solution and sediments downstream (Appleton et al. 1999) exceeding multiple international guidelines.

Different kinds of organisms were also recorded as having been contaminated with mercury from different main tailings. Contaminations were also found in rice, fish and mussels from Naboc River (Appleton et al. 2006; Drasch et al. 2001) and in three species of fish in Davao del Norte (Akagi et al. 2000). Population and biodiversity of damselflies and dragonflies in Surigao del Sur (Quisil et al. 2014) and oyster production in Zamboanga Sibugay Province (Lim and Flores 2017) have also been drastically affected by mine tailing ponds.

12.5 Efforts to Address Water Quality

Water quality is a physical and chemical problem. Several projects have been conducted both by the government and nongovernment agencies to address recurring and perennial challenges regarding the protection and conservation of water resources. Programs on the enhancement of water quality in the Philippines are spearheaded by the DENR with the support of various nongovernment organizations, financing institutions, and development partners (EMB 2014).

12.5.1 Environmental Management Bureau Projects and Programs

The DENR is mandated, through the EMB, to be the national authority responsible for the prevention and control of pollution and assessment of environmental impact. Aside from the enforcement and compliance activities of EMB in 12.3, the EMB

also take part in projects and activities to enhance and rehabilitate water quality throughout the country.

12.5.1.1 Designation of Water Quality Management Area

The Water Quality Management Area (WQMA) is established by the NWRB together with DENR to assign water quality management areas using appropriate physiographic units to protect water bodies and its tributaries (EMB n.d.b). The WQMA follows a two-step process by first initiating an assessment followed by the development of an agency Action Plan crafted to improve the quality of a certain body of water. Mindanao has ten bodies of water were designated as WQMAs in 2016.

12.5.1.2 Philippine Environment Partnership Program

The Philippine Environment Partnership Program (PEPP) was created to support self-regulation among industries towards improved environmental performance. The voluntary industry partnerships with DENR promote mandatory self-monitoring and compliance with environmental standards (DENR 2003). Under this program, PEPP evaluates and classifies establishments according to tracks. Industries classified as Track 1 are companies driven by competitiveness that go beyond compliance while Track 2 classified industries are companies that are currently unable to comply with regulations. Several companies have been awarded the Seal of Approval from Mindanao, but the first honor went to the San Miguel Brewery, Inc. in Darong, Davao Del Sur, Region 11. Other companies who received this recognition include many food, materials, and energy suppliers from Regions 10, 11, and 12 (DENR n.d.).

12.5.2 Financing Institutions and Development Partners

Financing institutions and development partners aid various projects aiming to promote, conserve, rehabilitate, and manage water quality. While the World Bank, Development Bank of the Philippines, JICA, and USAID all contributed to various national projects to protect, conserve, manage and rehabilitate the water bodies in the Philippines, we emphasize support for projects on Mindanao Island.

12.5.2.1 Land Bank of the Philippines

The Land Bank of the Philippines, together with the DENR, implemented the “Adopt-a-Watershed Project” restoring 14 hectare (ha) total area of denuded forestlands in six pilot areas nationwide (EMB 2014). (1 ha is equal to 10,000 m².)

Two major watersheds in Mindanao were covered in Phase 1(2006–2011) of this project, Lasang River in Davao Del Norte and Silway River in South Cotabato. In Phase 2 (2012–2015) of this project, 10 ha total watershed was covered in Mindanao, these are Paquibato, Davao City and Olympog in General Santos City. In the last Phase (2015–2018), and additional 14 ha of Mindanao watersheds found in Zamboanga Sibugay, Lanao del Sur, Davao del Norte, and South Cotabato will undergo restoration (Land Bank of the Philippines 2014).

12.5.2.2 Asian Development Bank

The Asian Development Bank (ADB) provided technical assistance to Cebu and Davao cities to improve access to water supply and sanitation services. The Urban Water Supply and Sanitation Project (2011–2014) aimed to increase continuous water supply in Cebu and Davao City by 2022 from 50 to 80% of the population while the coverage for clean and hygienic sanitation was targeted to improve from 10 to 50%. Furthermore, marine biodiversity ecosystems in the provinces of Cagayan de Oro and Davao Oriental were also allocated funds by ADB to enhance coastal services and reduce poverty among fisher folks (EMB 2014).

12.5.3 Research and Development Initiatives

Various research and development initiatives and programs conducted by DENR and Department of Science and Technology (DOST) have been reported to address water quality problems nationwide. DENR conducted leachate characterization study from various solid waste disposal facilities from 2005 to 2007 assessing the impacts of leachate on groundwater and studies on toxicity testing to assess the harmful effects of substances like cyanide, cadmium, mercury, arsenic, and nitrates with fish and invertebrate test organisms. The collected data from the tests were used in the formulation of parameters for environmental quality assessment and monitoring (EMB 2014).

The DOST also conducted various research and development initiatives geared towards prevention and control of water pollution under a five-year plan from 2011 to 2016 entitled, “Science & Technology Water Environment Roadmap.” Various programs and projects are investigating and implementing water technologies. They include water treatment technological improvement and innovation, wastewater treatment and remediation technologies, and space technology applications on water resources such as Light Detection and Ranging (LiDAR) technology and photonics for aquatic resource assessment (EMB 2014).

12.6 Recommendations to Improve Quality, Control, and Management

The environmental impact and negative health consequences elicited from water scarcity and pollution aid in refining the existing legal framework and policies on quality control, regulation on water usage, and water management. Major recommendations include policy amendments to the Philippine Water Code and Clean Air Act and various methods to further enhance local community involvement in government organized activities.

12.6.1 Policy Amendments

Major policy recommendations include the development of an institutional framework under the purview of the Philippine Water Code and amending the Clean Air Act to eliminate the use of concentration-based standards through the introduction of a two-tiered permit system. Suggestions include providing clarification of the roles and responsibilities of the various enacted national and local government units.

12.6.1.1 Centralized Regulation

A central regulatory body mandated within the main Philippine Water Code would provide an essential reporting structure that legally defines the framework for extraction, allocation, and management of the country's water resources. The transition to central control recognizes the presumably adequate existing law but may afford the necessary opportunity to successfully address the constant challenge of policy enforcement resulting from government institutions having overlapping functions and responsibilities (Rola et al. 2015). Thus, an institutional framework where all water users understand their roles and responsibilities should be enacted under the Philippine Water Code. The NWRB, currently enforcing the Water Code of the Philippines, is a prime candidate for transition. The existing organizational chart of NWRB allows conferring of water right but much of the proportion of water right is freely held by other public institutions like DENR (watershed management), LWUA (domestic water supply), and National Irrigation Administration (NIA) (irrigation water supply) as shown in Fig. 12.1.

This proposal reinforces the technical capacity and administrative function of NWRB by restructuring agency responsibilities to become the country's water resources management authority. Hence, a single, independent, and autonomous regulatory board will ensure the protection of water consumers, enshrine accountability and transparency throughout the water resource management of the coun-

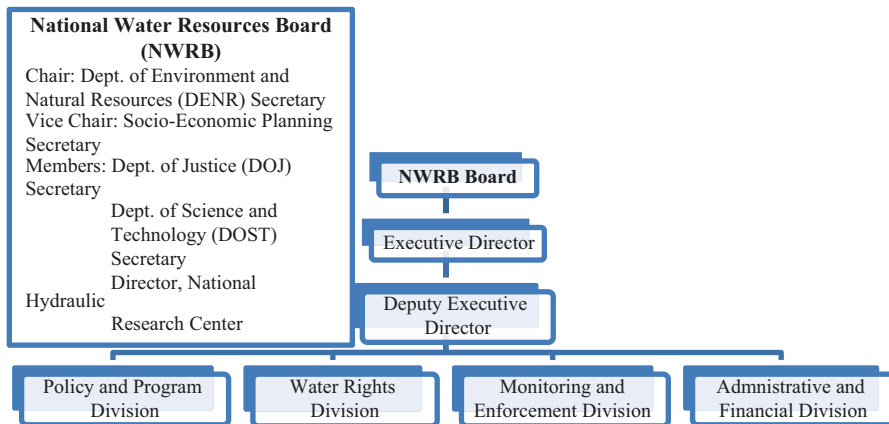


Fig. 12.1 Current organizational chart of National Water Resources Board (National Water Resources Board n.d., Used by Permission of Public Domain)

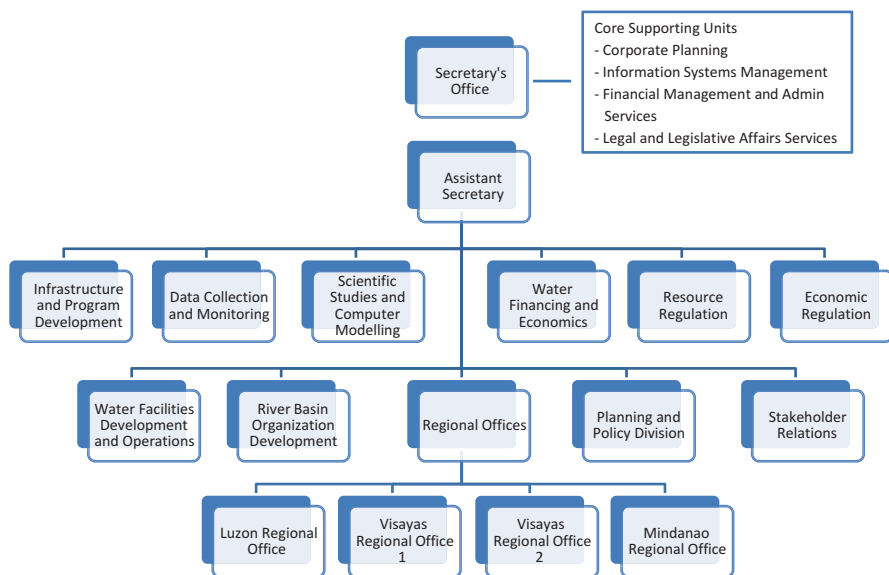


Fig. 12.2 Organizational chart of proposed National Water Resources Management Office (Tabios III 2014; Rola et al. 2015, Used by Permission)

try, and implement an honest and dynamic tariff policy. Further, these steps would streamline all projects and activities geared towards water quality improvement, sustainable allocation, and distribution among all users. The proposed central agency would carry the name National Water Resources Management Office (Fig. 12.2) having the mandate to manage and protect the country’s water resources.

12.6.1.2 A Two-Tiered Discharge Permit System in the Clean Water Act

The current policy on effluent standards, as mandated by Republic Act 9275, appears to be relatively insensitive to the real ambient conditions due to the use of concentration-based standards unconsciously allowing industries to dilute their effluent by over extraction of groundwater (Madrazo 2002). A two-tiered system for discharge permits mandated in the Clean Water Act should alleviate this problem. The proposed system charges industries for both the volume and concentration of water discharged thus encouraging industries to meet water quality standards to avoid paying higher environmental fees. Although many industries meet the standards set by law, the fees they pay will reflect the volume of effluent discharge addressing the dilution problem (Madrazo 2002). This revision on the provision of discharge permits has three primary benefits: (1) the Clean Water Act will become stringent in terms of reinforcing ambient water quality and effluent standards, (2) better water quality in receiving bodies of water, and (3) water quality improvements to communities' dependent on receiving bodies for livelihood and domestic purposes. Additionally, the environmental user's fee would produce additional benefits when disbursed to support data enhancing local water quality research, production of modern water treatment technology, implementation and enforcement of local ordinances through added personnel and equipment, and special training monitoring and inspection personnel.

12.6.1.3 Clarification of Roles and Responsibilities of National and Local Government Units

Under the current Clean Water Act, DENR is mandated with the responsibility to enforce various provisions under the said law. Although the agency is capable and competent, the current budget allocation is unlikely to increase covering the cost for additional personnel and equipment even when duties are added as prescribed by existing and new legislations (USAID and AECEN 2004). Thus, DENR operations will be hampered. To address this issue, a revision of the Clean Water Act must be made to devolve some of the functions of DENR to local government units. Local governments are in the best position to perform monitoring and inspection tasks because of existing personnel and available budget (Rola et al. 2015). Further, they can also more easily link monitoring to enforcement in their own new permitting system. Nevertheless, the LGUs require technical training which the DENR can provide. The revision for the Clean Water Act shall be based upon the reorientation of the task of DENR from reinforcement and implementation of the act to provision of standards, training, and oversight over LGUs. In this setup, LGUs will be empowered to effectively manage their own water resources, efficiently resolve local issues and concerns cutting the long delay of bureaucracy, and sustainably provide support and monitoring services for industries to forward local development. Furthermore, since LGUs are empowered they can easily identify issues and challenges and implement programs for the improvement of water quality involving local communities and barangays.

12.6.2 Local Community Involvement in Government Organized Activities

The civil society in the Philippines is very strong and vocal particularly in respect to the environment. National and local nongovernment organizations (NGOs) are very keen in monitoring proposed projects or activities that may pose serious deleterious effects to the environment. For this reason, tapping local community involvement and public participation in various government projects and activities is beneficial to the government, environment, and population. Recommendations encompass a series of local community involvement in government organized activities spanning the important aspect of citizen engagement in environmental impact assessments prior to development and community-managed services, among others.

Public participation in environmental impact assessment (EIA) activities is very significant not only in the process of consultations but also in the process of issuance and renewal of Environmental Compliance Certificates (ECC) (EMB 2007). Certain provision in the EIA requires the creation of a multisectoral monitoring team especially for major development projects. This provision allows public participations to ensure compliance with environmental standards by companies and industries as stipulated in the ECC.

EcoWatch Program is a private sector initiative listing and publicizing major polluters. DENR has adopted this initiative and encourages public participation in monitoring major polluters (EMB n.d.c). This system creates negative publicity for the involved firms since they are “color-coded” according to their compliance with environmental regulations. EcoWarch also allows public recognition and praise to firms and companies categorized as green, silver, and gold.

The Kapitbisig Laban sa Kahirapan-Comprehensive and Integrated Delivery of Social Project (KALAHI-CIDSS) is a World Bank project working with different impoverished communities in the Philippines. The project utilizes a community-driven development approach by enabling villagers to make their own decisions in identifying, developing, implementing, and monitoring development initiatives based on their current need (World Bank 2014). Public participation was very significant due to clearly established guidelines on participation, accountability, and transparency. Furthermore, an impact study revealed that the income of the household beneficiaries who participated in the project rose significantly by 12% as measured in terms of consumption (World Bank 2014, *para* 4).

There are numerous waterless municipalities around the country and about 213 are found in Mindanao (Llanto 2013). SALINTUBIG Project was conceived in 2011 by the DILG, DOH, and National Anti-Poverty Commission (NAPC). Their common objective is to provide water supply systems to the 455 waterless municipalities, barangays, health centers, and resettlement sites in the Philippines. To reach their goals community members and LGU personnel were given technical training in terms of planning, implementation, and operation of water supply facilities. This program emphasizes the capacity building mechanisms and the provision of technical assistance to LGUs in the pursuit of sustainable and efficient water supply services in the country (National Anti-Poverty Commission n.d.).

Cagayan de Oro City through the Cagayan de Oro Water District (COWD) sought the private sector to implement a design-build-operate contract for their septic facility. Through this setup, the private proponent will design and construct the treatment facility, purchase and operate desludging trucks, and implement a program for desludging septic tanks around the city. The local government on the other hand will approve a comprehensive citywide septic management ordinance, develop and targeted promotional campaign (USAID 2010).

The Philippine Center for Water and Sanitation (PCWS) assists in the creation of institutions providing technical assistance for the effective community management of water supply and sanitation systems. The formation of the Provincial Water and Sanitation Center in Agusan del Sur facilitated the capacity building of the municipal-level project implementers, providing sustainable support to community water and sanitation associations (Asian Development Bank 2006).

Lack of access to clean, potable water and improved sanitation is still a long-standing issue in most rural areas in the Philippines. Climate Resilience in Water Stressed Communities (CREST) is a project funded by USAID, local governments and communities in the Philippines to bring potable water to these areas and conflict-affected regions of Mindanao (USAID 2016). This project utilized a community-based, participatory approach to bring safe and potable drinking water through innovative water and water sanitation technologies resilient in the face of climate change.

Finally, the Estero Program is a collaborative effort among estero community members, local government units, private company donors, and DENR through EMB, to clean up waterways that empty into rivers and other bodies of water (EMB n.d.a). This is an effort to mobilize members of the community to actively engage in clean up, planning and implementation of continued plans to keep the estero clean in continuous projects. Immediate of their initial efforts that were observed by residents and other locals include less flooding due to unimpeded water flow and reduction of water-borne diseases.

12.7 Summary

Clean water is essential to improving the quality of public health. Therefore, maintenance and improvement of the quality of water is important to achieving this objective. In the Philippines, several legal frameworks and policies have been established with the mandate of quality control, regulation of water use, and water supply management. National government agencies, taskforces, and committees have been established in response to the implementation of laws and departmental administrative orders. These government agencies through various consultative meetings and research developed ambient water and wastewater emission standards for the protection of water bodies in the country. Although these legal framework and policies are in place, several obstacles are still presently challenging the realization of providing clean and potable water for all Filipinos. These challenges

are apparent in the fragmented establishment of legal policies cascading into weak reinforcement that, in turn, is ineffective in preventing pollutants from contaminating fresh and groundwater sources that impacts public health. Efforts must be made to address problems on water quality and pollution, shortage and scarcity of water, and the health and environmental impacts. This could begin in the development of a unified inter-agency and multisectoral taskforce on the management of water bodies. The system of rewards and incentives to improve environmental compliance of firms and industries must be further strengthened. Although several government agencies are mandated with the task of improving the water quality, this requires a multisectoral approach which necessitates the involvement of local government units and communities.

Initiatives by different civic societies and community associations are crucial in the improvement of the water quality throughout the island. Attention should also be given in the capacity building of local communities especially in their involvement on monitoring the compliance of different firms and industries. A good amount of investment must also be made in locally developed and produced sanitation and sewerage systems to introduce public accountability among every citizen. A community association must also be encouraged to manage water distribution and management of wastewater treatment facilities. These efforts to involve and engage local communities would address the challenge on the financial and personnel constraint of both the EMB and DENR. Together with the National Government, the rights and powers stipulated by legislative policies, support from various international and local Nongovernment Organizations, and active and responsible participation from local community members, the dream of providing clean, safe, and accessible water resources is possible. The rich resources of the Philippines must not be taken for granted and action must be taken before it's too late. The community, an untapped resource, must be involved in the various efforts to conserve and preserve the very foundation of life—water. Therefore, now is the time to revise and translate national laws and policies through the involvement of community to better the environmental condition of the Philippines.

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Glossary

Biological oxygen demand (BOD) Amount of oxygen dissolved in water required for the survival of microorganisms.

Coliforms Bacteria commonly found in soil, water, and in the guts of animals, which indicate that the water supply may be vulnerable to contamination.

Dissolved oxygen (DO) Amount of diatomic oxygen dissolved in water.

- Domestic** Refers to the utilization of water for drinking, washing, cooking, bathing, and other household chores and needs.
- Effluent** Wastewater discharged from a sewage treatment facility or an industrial plant.
- Industrial** Utilization of water for the needs of factories, industrial plants, and mines.
- Irrigation** Controlled application of water for agricultural uses through man-made systems to supply water requirements not satisfied by precipitation.
- Municipal** Utilization of water for supplying the water needs of the community.
- Potable water** Water that is safe for consumption or food preparation with no risk to health.
- Seawater Intrusion** The natural phenomenon where freshwater is contaminated with seawater because of overdraft—extracting too much water that leads to an unsafe imbalance in water quality.
- Sewerage** Collective term used for drains, canals, manholes, pumping stations, and screening chambers for disposal of sewage and surface water.
- Volatile Organic Compounds (VOCs)** Synthetic chemical compounds dissolved in water which can be vaporized at low temperatures.
- Wastewater** Water that has been used for various purposes in homes, industries, businesses that is not meant for reuse unless it is treated for contaminants.
- Water Quality Management Area** Certain water bodies and its tributaries identified by the Department of Environment and Natural Resources (DENR) to be prioritized for protection and conservation.
- Water Right** The right granted by the government to appropriate and use water.

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