

The Benefits of Establishing and Sustaining the Batangas Environment Laboratory in Batangas Province, Philippines

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Key Message

- A water quality monitoring program is a necessary component of integrated coastal management (ICM). It provides scientific data on pollution levels and impacts, serves as a useful basis for management planning, thereby informs and engages stakeholders on the state of the environment, and allows timely intervention.
- Maintaining an environment laboratory to support a monitoring program is costly but can eventually be sustained by stakeholders that require such services, particularly when the laboratory attains accreditation. It also increases local capacity, which can help with ICM scaling up and replication.

Abstract

The Batangas Environment Laboratory under the Provincial Government-Environment and Natural Resources Office of Batangas

Province (PG-ENRO) is the Philippines' first environmental monitoring laboratory operated by a local government. This experience demonstrated that providing quality laboratory services to local government and the private sector is not only feasible, but also an essential component of ICM. The laboratory was established in 1998 to overcome the problem of fragmented and inconsistent monitoring data collected by different academic institutions and private entities.

The local government recognized the crucial role of a laboratory in a monitoring program and persisted despite difficulties in maintaining it during the initial years. Local capacity in environmental monitoring enables quick detection of trends so that appropriate policy and management interventions can be activated within shorter response periods. This helps to improve governance, political will, and decisionmaking. Strong connections with stakeholders improved the sharing of

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information and knowledge, which allowed for faster collective decisionmaking. As a technical arm of the provincial government, the laboratory provides scientific data on the environmental quality of different water bodies including groundwater resources. Continued improvement and investments towards excellence have elevated it to a nationally accredited and internationally recognized laboratory. This case study highlights the need for an efficient environmental monitoring program to contribute to effective coastal management and the value of a dedicated environmental laboratory.

Background

The Province of Batangas established the ICM program in 1994 to help address the issues and challenges associated with pollution prevention and management (PG-ENRO, 1996; Chua, 2006; PEMSEA, 2006). The province was identified as a major industrial growth area in the Philippines, a center for port development and a trans-shipment hub (MTE, 1996). Batangas Bay was home to shipyards, petrochemical and oil refineries, and chemical, textile, and steel fabrication companies. The natural attributes of Batangas Bay made it suitable for port activities.

In the early 1990s, about 80% of ships docked in public ports while the rest in private ports. Industrial companies had their own port and berthing facilities and used the bay's shoreline for mooring, anchorage, and location of seawater intake pipes for cooling processes in their facility operations. Industrial expansion was leading to increased vessel traffic rendering adjacent areas unsuitable for fishing and recreational activities. With the upgrade of Batangas Port to an international, alternative port to Manila, shipping activity consequently was increasing which further intensified resource use conflicts, pollution, and the risk of oil spills and ship accidents.

Municipal and commercial fisheries were active but the encroachment of commercial fishers into the fishing grounds of municipal fishers was increasing the conflict between them and causing dwindling of fish stocks. Coastal and marine habitats were degraded because of overexploitation, overfishing, and use of illegal fishing methods. Erosion and siltation from the denuded watershed impacted heavily on seagrasses and coral reefs. About 61% of the province's total land area was devoted to agriculture, including coconut and sugar plantations, intermixed with backyard and commercial poultry and pig farming (MTE, 1996).

Growth of the coastal population and settlements was also accelerating with the expanding economic development further escalating the problems of domestic waste collection and disposal and the sustainable use of marine resources (MTE, 1996). Environmental (water) quality was deteriorating with the accumulation of solid wastes because of inadequate disposal facilities. The use of chemical fertilizers in agriculture was also increasing significantly. Controlling nonpoint sources of nutrients from backyard livestock raising activities was difficult. The disposal of untreated industrial wastes was also starting to become a concern. Domestic, industrial and agricultural wastes were entering the waterways, rivers, and coastal areas, aggravating the efforts in marine pollution prevention.

Prior to ICM adoption, monitoring data were fragmented and inconsistent based on studies by different academic institutions and private entities (PEMSEA, 2006). With the assistance of scientists from the University of the Philippines – Marine Science Institute (UP-MSI), baseline environmental data for the bay were acquired. The results of the environmental study showed that a potential health risk was imminent unless further efforts were taken to identify and assess pollution sources and the extent of pollution loads, and to institute pollution control measures. While

the principal use classification of Batangas Bay was for the propagation of fish and other aquatic life, beaches on the western side of the bay were being used for swimming, diving, and snorkeling. Regular monitoring of pollution levels including coliform counts was needed so that timely health advisories could be issued. This highlighted the need for an on-site laboratory with adequate equipment and qualified personnel. With the establishment of the ICM program, the Province of Batangas was becoming more cognizant of the challenges associated with pollution prevention and management, the need for sound scientific information, and the development of local capacity.

Approach and Methodology

Collaborative Water Quality Monitoring Program: the development of the Batangas Environment Laboratory

An initial five-year Integrated Environmental Monitoring Program (IEMP) was designed for the Batangas Bay region to regularly assess the state and trends in marine pollution and to ascertain what improvements were occurring as a result of pollution management schemes (Chua, 2006; PEMSEA, 2006). The primary concern of the local government was that an environmental monitoring program is costly. A strategy to create collaborative monitoring was explored for cost sharing and other financing instruments. The idea was to engage multiple partners in water sampling, data gathering, analysis and decisionmaking.

Institutionally, both a structure and an integrated monitoring platform were missing. It was not until 1995, when PG-ENRO was created and became operational that the blueprint for the Batangas Environment Laboratory (BEL) came into fruition¹. The functional multisectoral coordinating mechanism, Batangas Bay Region Environmental Protection Council (BBREPC), was also established.²

Prior to establishing BEL, an assessment of the capabilities of various institutions and companies to obtain and analyze marine environmental samples in the bay was carried out. The assessment also identified appropriate laboratories that could be engaged to create a self-sustaining monitoring program. The assessment activity involved visits to four hospitals, a water district office, two colleges, and 17 industrial firms. These institutions were identified as potential collaborators in the development and implementation of a marine pollution monitoring program where analysis of the major pollution parameters could be performed using existing laboratories in the bay area.

With the start of the monitoring program in 1998, PG-ENRO secured partnerships with various institutions. While it refurbished a small building to house BEL, hired two chemists, and provided a budget for maintenance and operating expenses (Figure 1), contributions were made by partner companies, and academic and local government institutions. PEMSEA provided other basic equipment needed by the laboratory.

¹ The PG-ENRO acts as the lead coordinating agency. It is primarily mandated to coordinate and integrate the implementation of management programs among the different stakeholders in Batangas. Its more significant tasks include: (1) developing the operational plans and strategies for implementing environmental and natural resources programs and projects; (2) enforcing pollution control and environmental protection laws, rules, and regulations; and (3) coordinating the ICM program among various stakeholders.

² The BBREPC is a venue for consultation and dialogue among the local government, national agencies, the private industries, academic institutions, and NGOs on the need for and utilization of monitoring information for management. It is chaired by the governor of Batangas. The BBREPC provides policy direction and oversees the formulation, adoption, and implementation of management interventions.

Figure 1. The BEL building in 1998.



Twenty sampling stations were designated as survey sites in Batangas Bay and two in Calumpang River in Batangas City (the largest tributary entering the bay). Water from these stations was sampled every quarter for basic parameters including biochemical oxygen demand (BOD), chemical oxygen demand (COD), total coliform and fecal coliform, nutrients, oil and grease, transparency, chlorophyll, salinity, temperature, and pH.

Initial challenges

The initial five-year plan to sustain the marine pollution monitoring program lasted only two years. It did not succeed as planned. Most of the Memoranda of Agreement between PG-ENRO and its partners were not renewed due to lack of initiative and interest. Co-financing arrangements with the industries involved in the monitoring activities, as stipulated in their Environmental Compliance Certificates, were not followed through. The BEL personnel also experienced difficulty in coordinating and conveying water samples to the private laboratories. One partner agency complained of additional workload on its quality control department. In some instances, the BEL personnel had to analyze samples in the laboratory of a partner due to insufficient staff. Addressing logistics requirements such as access to a boat and fuel use also became a problem. The Philippine Coast Guard (PCG) had only a small

budget for fuel and no available boat. Another partner could only provide a small boat which posed safety risks to BEL personnel. In 2000, PG-ENRO stopped collaborating with partner agencies in monitoring except PCG. This was a difficult period for the laboratory because of insufficient budget.

However, BEL continued with the analysis of water quality parameters including pH, temperature, and nutrients (i.e., ammonia, phosphate, nitrate, and nitrite). From 2000 to 2003, PCG used its tugboat for water sampling but this arrangement had to be stopped due to increasing gasoline consumption. Subsequently, a stronger coordination with the Province's General Services Office was effected in order to acquire 45 liters of gasoline per sampling activity. The gasoline, in turn, was supplied to a private boat in exchange for their services of transporting BEL personnel during sample collection within the Batangas Bay area.

Adjustments made

Due to financial constraints and lack of personnel, BEL reduced the monitoring sites to 8 instead of 22 stations as initially identified. The basis of monitoring station selection in Batangas Bay was the point and nonpoint sources of pollutants and those within the mixed zone of industries operating within the Bay area.

On 19 March 2003, the PG-ENRO through BBREPC facilitated the approval of Sangguniang Panlalawigan Resolution No. 077: “A Resolution Passing into Law Provincial Ordinance No. 3-S. 2003 Authorizing the Imposition of Fees for the Services Rendered by the Batangas Environment Laboratory (BEL).” The law will sustain the operation of BEL because its operation is expensive for the provincial government.

The BEL also tapped funds from the Department of Energy (DOE) through Energy Regulation 1-94A which stipulates that 1% of 1 centavo per kilowatt hour generated by a power plant shall be set aside for Electrification Fund (EF), Development and Livelihood Fund (DLF), and Reforestation, Watershed Management, Health and/or Environment Enhancement Fund (RWMHEEF). A proposal for the procurement of equipment to be used by BEL was submitted to DOE and on 7 November 2002, the National Power Corporation and the Province of Batangas entered into a Memorandum of Agreement allocating PhP 5.25 million (US\$ 102,000) for additional laboratory equipment.

The BEL bought an atomic absorption spectrophotometer with vapor generation accessory for heavy metals analysis, BOD meter assembly, COD assembly, bacteriological

measuring equipment, and ambient air quality monitoring equipment for total suspended particulate, sulfur dioxide and nitrogen dioxide, and a noise level meter.

Simultaneously, PG-ENRO worked out the transfer of BEL laboratory facility to the Sangguniang Kabataan Building, a two-storey building adjacent to the PG-ENRO building to accommodate the additional equipment. Then Governor Hermilando I. Mandanas allocated a budget for the laboratory fixtures amounting to PhP 900,000 (US\$ 17,000). On 24 June, 2004, the Province inaugurated the upgraded BEL facility (Figure 2).

Another problem encountered with the program was the frequent turnover of chemists who were moving to more stable jobs. Several justifications were made to increase the number of personnel in the laboratory and to create additional positions for the BEL operation. In 2011, two Environmental Management Specialist positions were created. The BEL then started working on the accreditation or recognition of water, and wastewater quality parameters by the Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB). In February 2005, the DENR-EMB Central Office and the DENR-EMB Region 4A conducted the first level assessment of the laboratory.

Figure 2. The BEL facility starting 2004.



Results

The BEL facility today is operated by four full-time chemists in addition to three laboratory personnel. The PG-ENRO water quality monitoring program now covers Batangas Bay (eight stations) and Calumpang River (nine stations) (Figure 3). Additional stations are monitored in response to requests (and complaints of pollution discharges). In mid-2007, PG-ENRO initiated the monitoring of coastal waters of Balayan Bay covering five stations.

The BEL now has the capability to analyze water quality parameters for water and wastewater and ambient air as shown in Table 1.

The Provincial Government approved a PhP 29 million (US\$ 620,000) budget for a new PG-ENRO

building inclusive of a new laboratory with rooms for microbiological analysis, air quality analysis, instrumentation for toxic metal and trace organics analysis, a storage area for chemicals, a hot room and a central laboratory where other water analysis can be carried out.

Contributions to planning and decisionmaking

Knowledge sharing and direct linking of information to management

The sharing of monitoring data leads to collective understanding of the benefits and impacts of management interventions. As such, it is imperative that monitoring information is accurate, relevant, and regularly communicated to managers and decisionmakers.

Figure 3. Water quality monitoring program in Batangas Province.

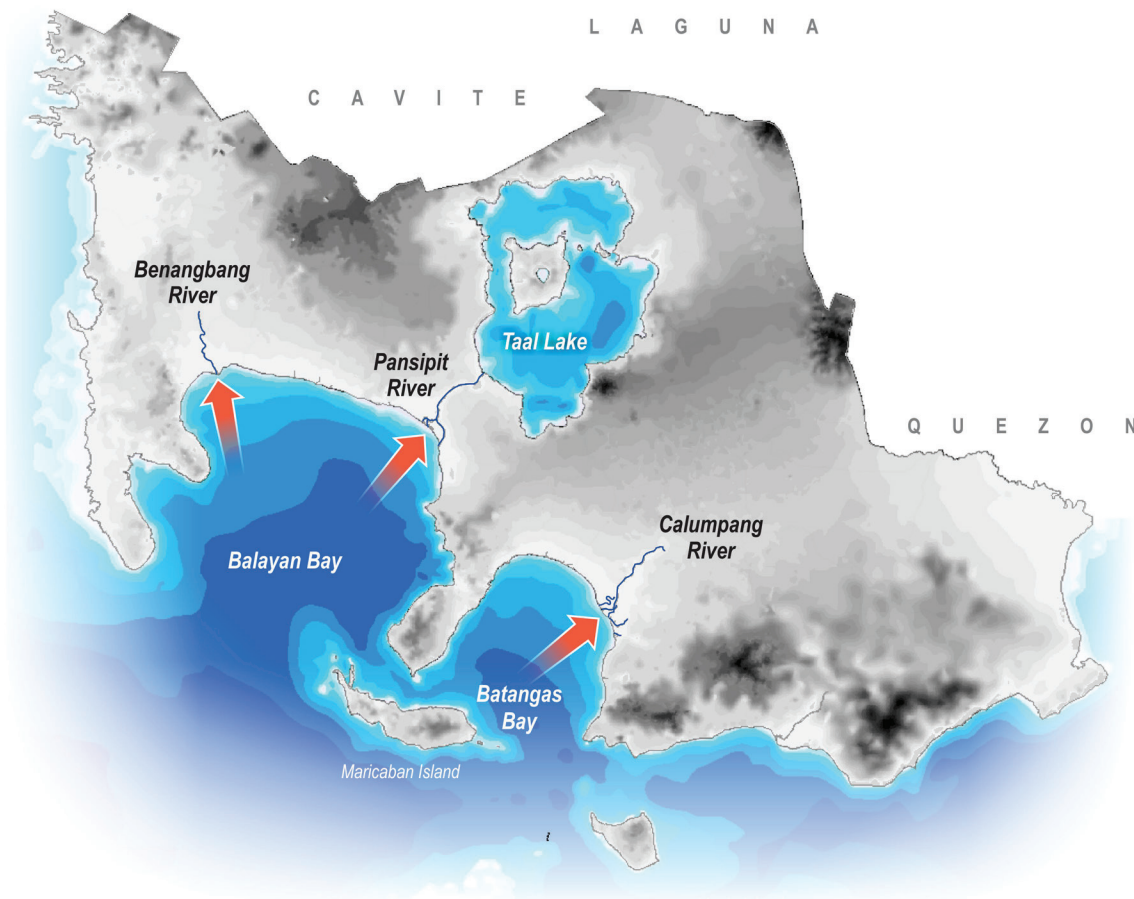


Table 1. Water quality parameters performed by BEL.

Type of sample	Water and wastewater quality parameters
Potability testing	acidity, alkalinity, ammonia, carbonate and bicarbonate, color, turbidity, hardness, magnesium, chlorides, total solids, settleable solids, conductivity, total dissolved solids, resistivity, salinity, odor, nitrate, phosphate, lead, chromium hexavalent, total chromium, manganese, zinc, copper, cadmium, iron, pH, temperature, <i>E. coli</i> , total coliform count, fecal coliform count, heterotrophic plate count
Fresh, marine and waste water	total solids, settleable solids, total dissolved solids, odor, nitrate, phosphate, lead, chromium hexavalent, total chromium, manganese, zinc, copper, cadmium, iron, dissolved oxygen, pH, temperature, phosphate, total suspended solids, total coliform count, fecal coliform count, BOD, oil and grease, <i>E. coli</i> , COD
Ambient air	total suspended particulates, sulfur dioxide, nitrogen dioxide
Noise level	decibels

The Province of Batangas' ICM program adopted a long-term and transparent water quality monitoring strategy, which proved very useful in understanding the resource systems of the Batangas Bay area. A quarterly report on the state of the region's water quality was prepared and submitted to BBREPC. For example, over the years, the results of the monitoring program indicated that there was a significant decrease in total coliform count (TCC) in Barangay Tabangao from 160,000 and 500,000 MPN/100mL for May 2009 and June 2011, respectively, to less than 300 MPN/100mL for the years 2012 to 2015. The TCC in other sampling stations were below the DENR Administrative Order No. 34 Guideline Value for Class SC Waters which is 5000 MPN/100mL (Figure 4). The dissolved oxygen (DO) in Batangas Bay remained within the acceptable guideline value, with the exception of a sampling in June 2007 that coincided with heavy rains (Figure 5).

Special meetings were held to address emerging issues or emergencies. This regular monitoring provided the local government with timely information about water quality in the bay and allowed problems such as harmful algal blooms and fish kills to be identified immediately.

The data generated were used to pinpoint hotspots and to identify necessary management interventions. For example, results of the Pansipit River water quality monitoring showed that the total coliform levels in some parts of the river (Figure 6) exceeded the guidelines value for Class B waters of 1000

MPN/100mL, indicating the continuous discharge of untreated domestic sewage and animal waste as the likely sources of contamination.

Several pollution complaints were received and acted on by BEL providing sampling and analysis of wastewater. The results indicated that some industries and establishments were discharging wastewater that did not conform to water quality standards set by DENR. Such good practices heightened the awareness of local government executives on the importance of scientific data to identify establishments that were polluting water bodies in the province. More importantly, pollution issues were immediately addressed through specific interventions.

Replication and increased public awareness and participation

The ICM program in the Batangas Bay Region has now been expanded and replicated to include the Balayan Bay area and key river systems. The PG-ENRO's- BEL monitoring activities in Batangas Bay area has likewise expanded.

The monitoring program in the Balayan Bay area started in 2007 through a small grant from PEMSEA to Anak Balayan, a people's organization in Balayan, Batangas. In response to the request of the Municipality of San Luis in Batangas and in support of the mangrove planting project of PG-ENRO Forest Management Section, the monitoring activity was

Figure 4. Monitoring data of total coliform count in Batangas Bay, 2004–2015 (adopted and updated from PG-Batangas and PEMSEA, 2008).

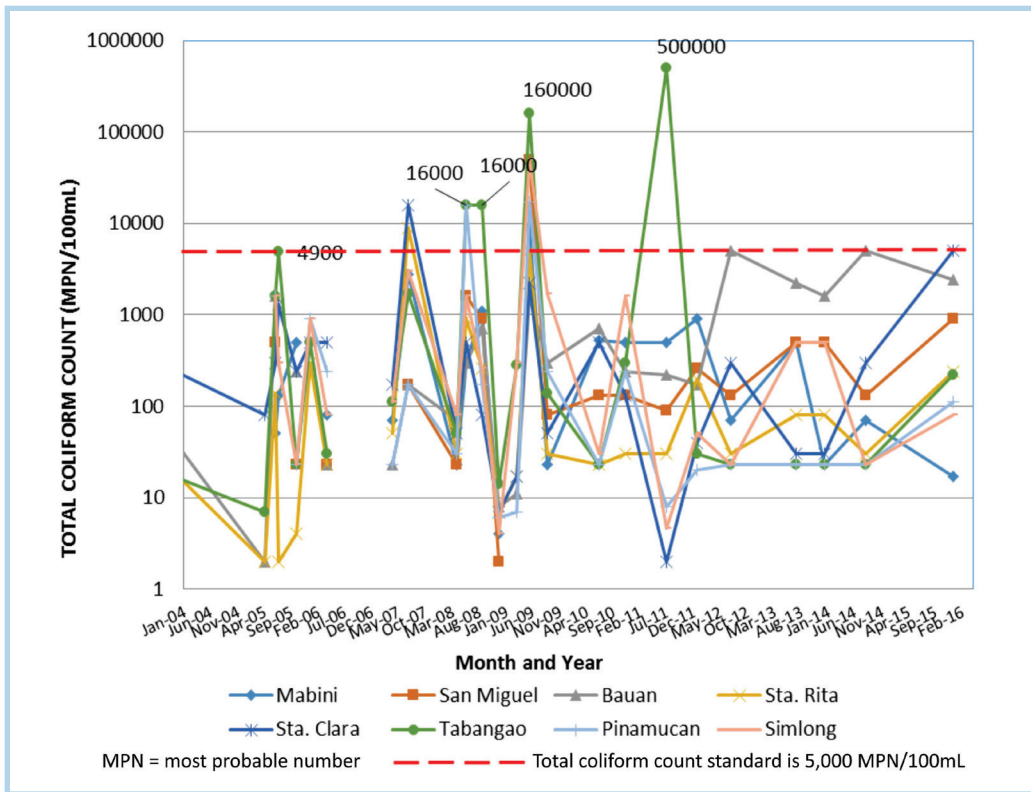


Figure 5. Dissolved oxygen in Batangas Bay, 2004–2015 (adopted and updated from PG-Batangas and PEMSEA, 2008).

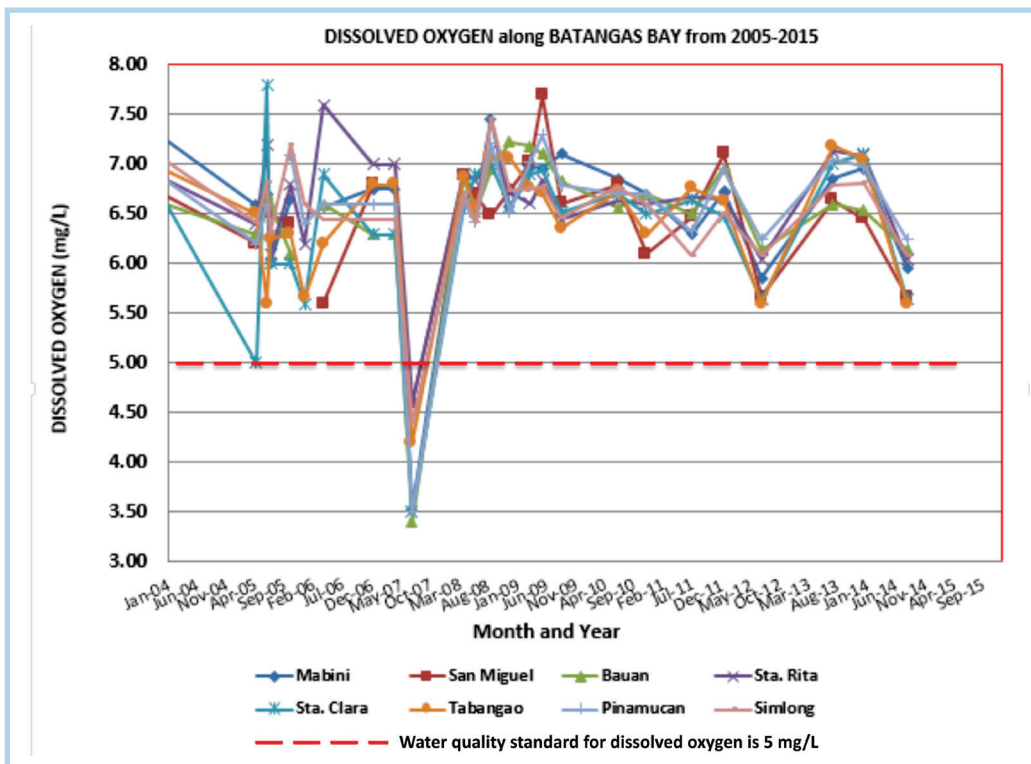
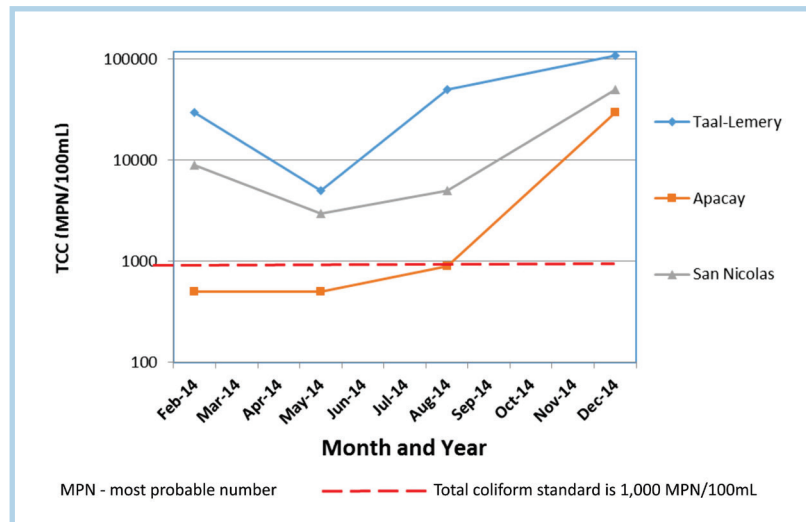


Figure 6. Total coliform count in Pansipit River, 2014.

extended to San Luis coastal area. Results showed that there was a decrease in total coliform count especially in stations in Binambang and Barangay 9 with reference to the results in 2007 (Figure 7). The TCC in other stations showed conformance to the guidelines value set in DENR Administrative Order No. 34 for Class SC Waters, i.e. 5000 MPN/100mL. Figure 8 shows that dissolved oxygen levels in Balayan Bay area were consistently conforming with the DENR minimum guidelines value of 5 mg/L.

The BEL also attended to complaints on river pollution and assisted in the river rehabilitation programs of selected local government units. One of the notable programs involving BEL's assistance was the rehabilitation of Kawakawa River, a project launched by SANDIWA Multipurpose Cooperative, a nongovernment organization in San Jose, Batangas. The BEL conducted water quality assessment of the river stream which led to the identification of various sources of agro-industrial pollution coming from different tributaries of Kawakawa River. The results of the water sampling activities facilitated the resolution and/or minimization of pollution problems in the area. The monitoring results were used by the SANDIWA Multipurpose Cooperative to

mobilize the community to participate in the river cleanups. Consequently, the river was launched as a swimming and laundry area for public use, creating heightened community awareness and participation in cleanups, watershed management, and water recycling.

Stronger partnerships with industries and the academe

Multisectoral collaboration among stakeholders within the Batangas ICM system was enhanced as a result of the knowledge gained through the monitoring program and the analysis of results. There is now an appreciation of the changes in environmental trends and how the resource system of Batangas is responding to development and other interventions.

The partnership with industries through participation in the quarterly meetings, where results of quarterly monitoring in Batangas Bay area were presented to members of the Batangas Coastal Resources Management Foundation (BCRMF), has been strengthened. Since the monitoring stations are within the mixed zone of several industries within the Batangas Bay area, the results regularly flag selected industries on the status of ambient water quality in the bay area.

Figure 7. Total coliform count in Balayan Bay, 2007–2013.

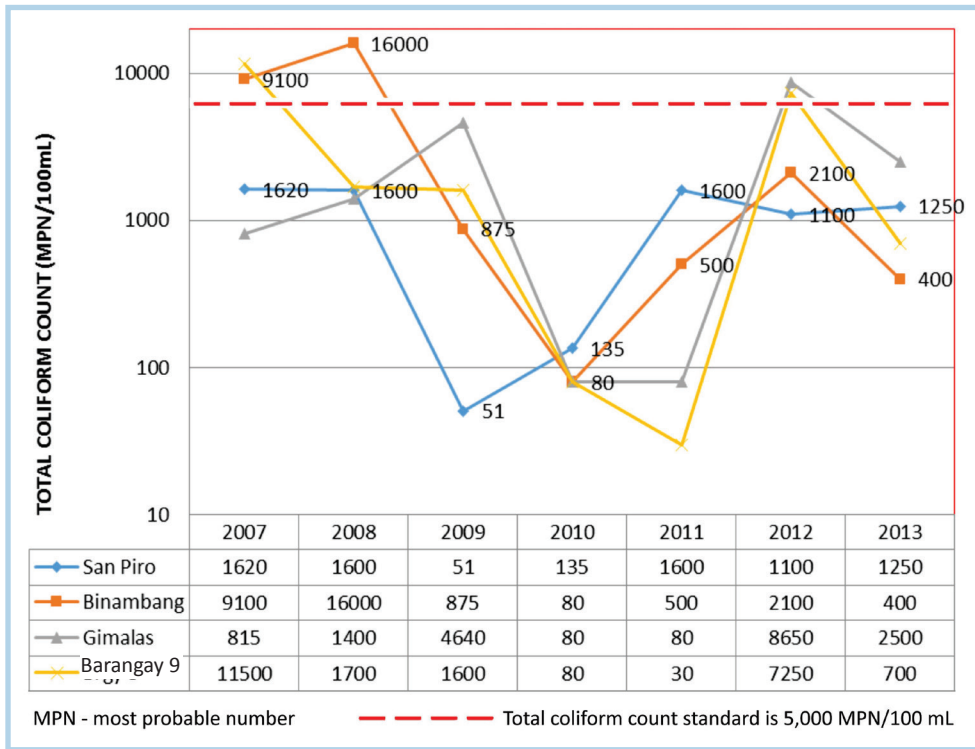
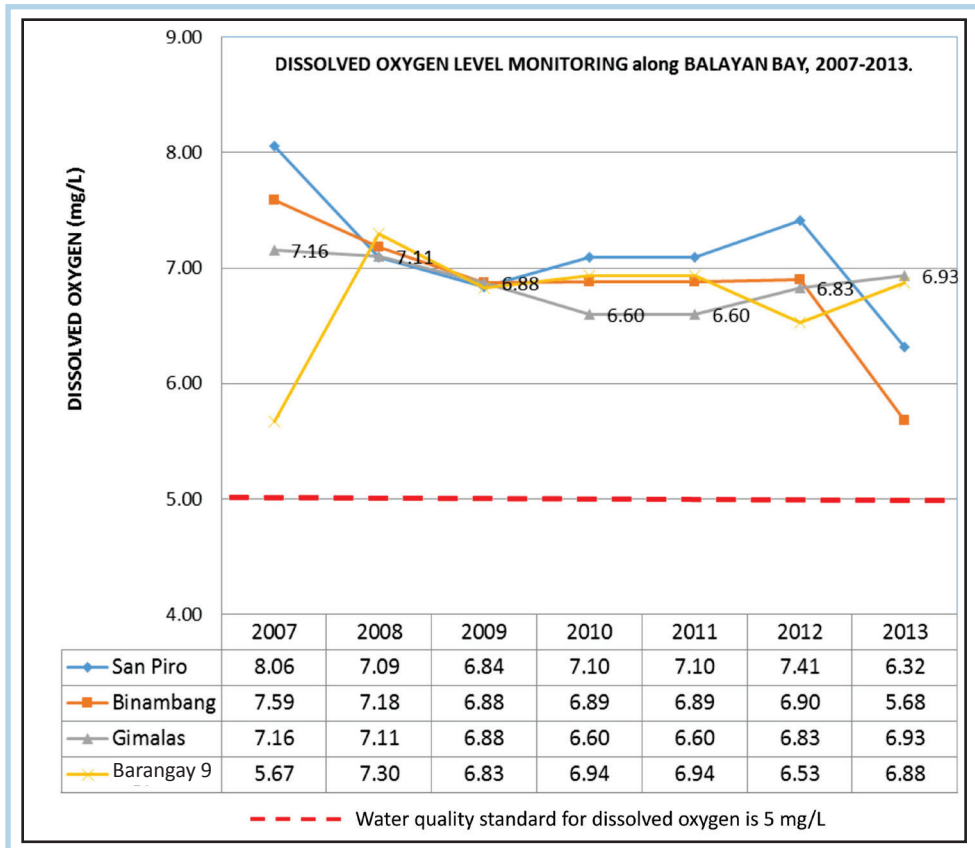


Figure 8. Dissolved oxygen in Balayan Bay, 2007–2013.



The BEL was able to acquire data from the results of water quality testing of different rivers within the province by giving assistance and/or accepting clients from academe partners/clients, which identify rivers within the province as their study areas. Although, the data generated were treated as privately owned, they were used as reference material when needed.

Sustaining the monitoring program

Return on investment

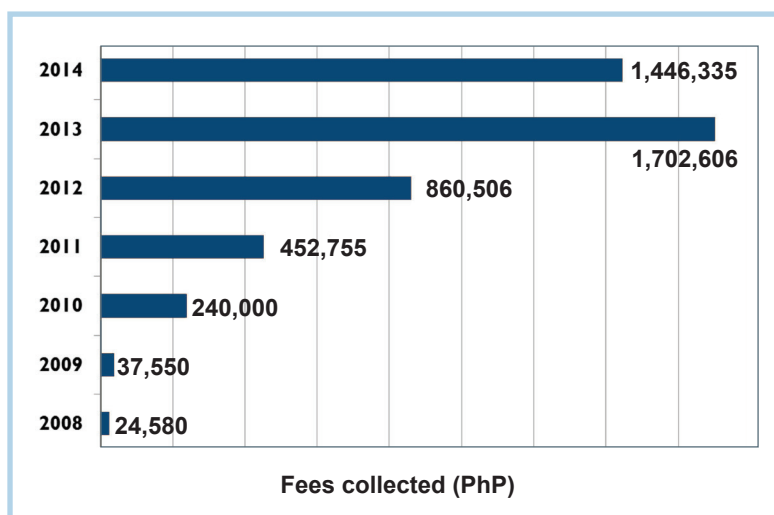
Private clients have become a source of income for BEL and an important contribution to the continued monitoring of the environmental quality of ambient air and water within the province using the laboratory's facility. The BEL also led in responding to several pollution complaints lodged at PG-ENRO relating to water and air pollution. In 2012, BEL was able to collect PhP 860,506 (US\$ 20,000) from private clients of which, about PhP 211, 260 (US\$ 5,000) was spent for monitoring purposes. The amounts were based on the schedule of fees stipulated in Provincial Ordinance No. 003 S. 2003. In 2013, the collected revenue amounted to about PhP 1.7 million (US\$ 40,000) (Figure 9).

Aside from supporting the income generation objectives of the province, accepting influent, effluent, freshwater and seawater samples with corresponding fees from private clients helps PG-ENRO in monitoring the quality of industrial wastewater being discharged to bays and rivers. This has no additional cost to the provincial government. Table 2 shows the corresponding increase of water sampling and analysis both for monitoring and those received from private requests.

Certification and excellence

The BEL continued to improve as an environment laboratory and sought certification and recognition

Figure 9. Return on investment: total fees collected, 2008–2014 (average exchange rate: US\$1: PhP44.2293).



for excellence (Figures 10–11). To be able to pursue its plan to accommodate environmental samples for compliance monitoring of industries and to generate environmental data in connection with the environmental impact assessment system, environmental monitoring and research activities in support of the formulation and implementation of policies, criteria, guidelines, rules and regulations and other activities of the Environmental Management and Protected Area sector of DENR, BEL secured all requirements for recognition from different certifying agencies. Some of the requirements are Hazardous Waste I.D. Registration issued in March 2006, Environmental Compliance Certificate issued in December 2007, Certificate of Compliance to the Regulation of Fire Code of the Philippines of PG-ENRO BEL Project issued in October 2008, and Accreditation for Pollution Control Officer issued for the Batangas Environment Laboratory Project in September 2008. Finally, DENR certificate of recognition was signed by the DENR Secretary in June 2009. The BEL also worked on its accreditation by the Department of Health (DOH) which was issued in July 2012.

To date, BEL has 28 ambient water and air quality parameters recognized by DENR-EMB and is accredited by DOH for bacteriological, physico-chemical and heavy metals parameters.

Table 2. Water sampling and analysis demand.

		2007	2008	2009	2010	2011	2012	2013	2014
Number of sampling done	Monitoring	9	37	9	15	22	43	6	10
	Private	1	9	22	25	50	89	78	88
Number of samples	Monitoring	35	40	92	28	119	657	11	96
	Private	5	35	46	109	310	409	347	451
Number of analysis conducted	Monitoring	105	320	442	249	389	1,060	40	856
	Private	25	140	162	814	1,151	2,452	2,016	3,296

On 31 August 2014, BEL was awarded the PNS ISO/IEC 17025:2005--Certificate of Accreditation in the field of Chemical Testing as specified in the Scope of Accreditation. The accreditation recognizes BEL's technical competence for specific tests or measurements for drinking water, sewage, industrial wastes, other waters such as fresh, marine, and ground water and the operation of a laboratory quality management system that meets the principles of ISO 9001:2008.

Scaling up the investments for ICM

The DENR Protected Area Management Board designated Taal Lake as a Water Quality Management Area. As a partner agency of the Batangas Province, DENR tapped the services of BEL to take part in the establishment of monitoring sites in lakes and river tributaries. The BEL serves as their third party laboratory. Likewise, BEL is in partnership with DENR-Protected Area Wildlife and Coastal Zone Management Service both in western and eastern Batangas for the establishment of monitoring sites for water quality assessment in marine protected areas of Fuego Point in Nasugbu, Bagong Silang in Calatagan, Maricaban Strait in Tingloy, and Pagkilatan in Ilijan, Batangas City. The data generated served as reference for the province to identify which areas are considered as environmental hot spots and need intervention. This is also true in the case of ground water resources where community awareness of the continuous depletion of ground water has been the basis for

launching watershed management initiatives and water recycling among LGUs, national government agencies, and the industrial sector.

Lessons Learned

More effective pollution management under an ICM program can be feasible with the establishment of an environmental monitoring laboratory by a local government.

Local capacity in environmental monitoring can enable quick detection of trends so that appropriate policy and management interventions can be activated within shorter response periods. This helps to improve governance, political will, and decisionmaking and improve confidence and efficiency in project operation and implementation.

For example, in Batangas, pollution control measures were established for identified sources of pollution, particularly for livestock raising enterprises. Environmental Clearance (EC) approval was incorporated into the Batangas Province Environment Code (2012). The EC approval is issued to the requesting industry only after the sampling and analysis of its wastewater/sewage treatment plant discharges are completed and proven to be within acceptable limits.

Batangas' strong connections with its stakeholders improved the sharing of information and

knowledge, which allowed for faster collective decisionmaking and made BBREPC more sensitive to issues on the ground. Making scientific information/advice available at the local level can improve efficiency, effectiveness, and relevance of management interventions. For example, communities were mobilized for coastal cleanups in response to high coliform levels in analyzed water samples. Residents were also directed to refrain from using the coasts and rivers as dumping areas for household and sanitary wastes. The monitoring information facilitates direct linkages between scientific data, decisionmaking, and action. It further strengthens community awareness and participation in management interventions.

Enhancing public awareness and participation in all phases of the program development, implementation, and monitoring promotes perception change and ownership.

Monitoring data can give a better understanding of how water bodies and the associated resource systems respond to development and management actions.

This was particularly evident for the BEL monitoring data for the Calumpang River, the main tributary to Batangas Bay. The river acts as a catchment basin for all domestic and livestock wastes under the jurisdiction of two cities and

Figure 10. DENR-EMB compliance audit of BEL.



Figure 11. Certificate of Recognition/ Accreditation by DENR and DOH.



six municipalities. An extensive water quality monitoring program identified priority pollutants and potential sources of contamination. The Calumpang River cleanup was included as a priority of the Batangas Bay Rehabilitation Program.

Continuous improvement and investments in excellence can elevate the capacity and recognition of a local laboratory to an internationally recognized laboratory.

The BEL is now the technical arm of the provincial government of Batangas providing scientific data on the environmental quality of different water bodies. The local government recognized the crucial role of a laboratory for a monitoring program and persisted despite difficulties in maintaining it during the initial years. The BEL operates as a DENR and DOH-recognized laboratory and monitors not only the water quality of Batangas Bay and Balayan Bay and their tributaries but also ground water resources in the province. Its success did not come overnight but through a painstaking, day-to-day decisionmaking, learning, and performance evaluation process. The laboratory's staff remain committed to the provision of quality testing by consistently improving and expanding BEL services and maintaining compliance with the requirements of regulatory bodies and the Philippine National Standard ISO/IEC 17025:2005.

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