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TOWARD A COMPREHENSIVE WATERSHED MANAGEMENT STRATEGY FOR MANILA BAY

THE INTERNATIONAL EXPERIENCE AND LESSONS LEARNED

Toward a Comprehensive Watershed Management Strategy for Manila Bay — The International Experience and Lessons Learned

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TOWARD A COMPREHENSIVE WATERSHED MANAGEMENT STRATEGY FOR MANILA BAY

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CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AMA	–	Agricultural Management Assistance
BMPs	–	Best Agricultural Management Practices
CAFOs	–	Concentrated Animal Feeding Operations
CBPO	–	Chesapeake Bay Program Office
CEEP	–	Centre Européen d'Etudes sur les Polyphosphates
CES	–	Cooperative Extension Service
CIS	–	Common Implementation Strategy
COD	–	Chemical Oxygen Demand
CRP	–	Conservation Reserve Program
CSP	–	Conservation Stewardship Program
CTA	–	Conservation Technical Assistance
CWA	–	Clean Water Act
DENR	–	Department of Environment and Natural Resources
EEA	–	European Environment Agency
EPA	–	Environmental Protection Agency
EQIP	–	Environmental Quality Incentives Program
EU	–	European Union
FSA	–	Farm Service Agency
GEF	–	Global Environment Facility
MB	–	Manila Bay
MBEMP	–	Manila Bay Environmental Management Project
MEP	–	Maximum Extent Practicable
MINAS	–	Mineral Accounting System
ND	–	Nitrate Directive
NEDA	–	National Economic Development Authority
NGOs	–	Nongovernmental Organizations
NIFA	–	National Institute of Food and Agriculture
NMP	–	Nutrient Management Plans
NRC	–	National Research Council
NRCS	–	National Resource Conservation Service
NVZ	–	Nitrate Vulnerable Zones
OECD	–	Organisation for Economic Co-operation and Development
OPMBCS	–	Operational Plan for the Manila Bay Coastal Strategy
P&G	–	Procter & Gamble
PEMSEA	–	Partnerships in Environmental Management for the Seas of East Asia
PES	–	Payments for Ecosystem Services
PROA	–	Pollution Reduction Opportunity Analysis
PROA	–	Pollution Reduction Opportunity Analysis
PWS	–	Payment for Watershed Services
RTC	–	Regional Trial Court
SAV	–	Subaquatic Vegetation
SWCD	–	Soil and Water Conservation Districts
TMDL	–	Total Maximum Daily Loads
TN	–	Total Nitrogen
TP	–	Total Phosphorus
UNDP	–	United Nations Development Programme
USDA	–	U.S. Department of Agriculture
USEPA	–	U.S. Environmental Protection Agency
USGS	–	U.S. Geological Survey
WFD	–	Water Framework Directive
WRI	–	World Resources Institute
WWTPs	–	Wastewater Treatment Plants

EXECUTIVE SUMMARY

Recommendations for the Manila Bay Management Strategy

Based on experience in other international efforts to restore and protect major water bodies, the World Resources Institute (WRI) was requested to develop a set of preliminary recommendations for strategies and tools for use in the restoration of Manila Bay. This report should be considered preliminary in that it is based on a brief introduction to Manila Bay issues and application of lessons learned from other international experience.

The recommendations are broken down into four general categories: management approach, technical approach, specific tools, and some additional observations that may be useful.

Management Approach

A comprehensive management strategy is needed for Manila Bay. This approach is clearly embodied in the Manila Bay Coastal Strategy, the Operational Plan for the Manila Bay Coastal Strategy, and the Supreme Court mandamus. The Coastal Strategy, Operational Plan and mandamus collectively address all causes of degradation and sources of pollution, ranging from untreated sewage to poor solid waste management to overfishing, and identify actions that must be undertaken to address them, as well as assigning responsibilities and setting timetables.

The Department of Environment and Natural Resources (DENR) of the Philippines is the primary agency responsible for the "conservation, management, development, and proper use of the country's environment and natural resources" and for the implementation and enforcement of the Operational Plan for the Manila Bay Coastal Strategy. Consideration should be given however, to going beyond this assignment of responsibility and establishing an organizational unit whose sole responsibility would be ensuring compliance with the mandamus and the successful implementation of the Operational Plan, i.e., a Manila Bay Management Bureau. The bureau could be led in DENR, and housed there, but with some staffing provided by other key agencies, making it, in reality, an interagency task force. Its responsibilities could include:

- Setting priorities (e.g. needed research, activities, implementation sequence, resource allocations);
- Oversight of efforts in all sectors;
- Program assessment;
- Progress reporting;
- Public education;
- Public participation; and
- Communications with elected officials

Technical Approach

The Coastal Strategy, Operational Plan, and mandamus recognize the need for a holistic watershed approach, one that addresses all of the causes of the bay's degradation. The strategy must:

- Establish a comprehensive water quality and pollutant loading monitoring program;
- Identify all sources of harmful pollution;
- Quantify pollutant loads by source, sector, and location;
- Enable the development, calibration, and verification of watershed and water quality models;
- Assess the impacts of pollutant loads to Manila Bay from all sources and sectors;
- Establish maximum allowable pollution loads to Manila Bay for each important pollutant (pollution budget or watershed cap);
- Develop and evaluate alternatives for reducing pollution loads;
- Allocate allowable pollutant loads to sectors, regions, and sources.

All sources and sectors must be included in this analysis and accounted for under the loading caps. Otherwise, the caps would be meaningless. WRI recommends that holistic watershed caps be established and all sources and sectors should be included in the cap and assigned allocations. These sectors and sources include wastewater effluent, untreated sewage, garbage and trash, urban runoff, direct and indirect industrial discharges, agriculture, atmospheric deposition, septic systems, phosphate detergents, marine vessels, and possibly other sources.

The allocation of allowable loads is not simply an ad hoc mathematical exercise, but rather a complex set of policy decisions on how to distribute the cost of restoration to different sources. The role of science in the process is to identify the sources and loads and to determine if different control actions are equivalent, i.e., produce the same water quality response and have the same degree of uncertainty. Following this comes the hard work of integrating all of the technical, social, and economic factors in the setting of the allocations. WRI has developed an analytical approach called a Pollution Reduction Opportunity Analysis (PROA) that evaluates pollutant loadings from all sectors and sources, methods of reducing the loads for all sectors, the amount of reductions that are feasible, and the cost per kilogram of reduction per year for each method in each sector. This allows a clear graphical presentation of reduction opportunities and cost-effectiveness of the various options. The results of two PROA's done elsewhere by WRI are described in Section 4.3.

Adaptive Management

The restoration of Manila Bay is a massive undertaking. Many problems, some never before adequately addressed, will have to be dealt with. There is much to be learned about the causes and cures for Manila Bay's degradation and the development of sufficient scientific understanding is in its early stages.

Some conclusions are obvious, however, and better scientific understanding is not needed in order to make decisions on whether or not to take specific actions. In many areas, however, more data and scientific understanding is needed and many questions must be answered along the way to a final solution. For these reasons, an adaptive management approach involving the following steps is necessary:

1. Assess the problem;
2. Design solutions;
3. Implement the solutions;
4. Monitor the effects of the solutions;
5. Evaluate the results;
6. Make changes to the solutions to improve the results; and
7. Return to step 1 and repeat the process.

There are some areas where actions need not wait for additional research or planning deliberations. Candidates include implementing a phosphate detergent ban, building landfills and implementing good solid waste management, and perhaps improving fertilizer and manure management practices in agricultural areas.

A key principle of adaptive management is that *things don't have to be perfect in order to proceed.*

Phosphate Detergent Ban

Although phosphate detergent bans were initially strongly resisted by detergent manufacturers, they are widespread today in Europe, North and South America, and Asia. The bans drove innovation by the manufacturers and the industry has largely adapted. Many major international manufactures have or are in the process of completely eliminating phosphates from their detergents.

Phosphate detergent bans are least effective in areas that have a high level of sewage collection and treatment and most effective in areas lacking sewage collection and treatment. There are significant discharges of raw sewage to Manila Bay. Hence, a high proportion of the phosphates in detergents used in homes or businesses that are not connected to sewers or properly operating septic systems enters streams, rivers and Manila Bay.

Under these circumstances, a phosphate detergent ban could have immediate and significant environmental benefit. The detergent industry as a whole has adapted to phosphate bans and can easily and quickly move to low or no phosphate detergents in the Philippines, hence a ban in the Manila Bay watershed could be rapidly implemented and result in an immediate reduction of phosphorus loads to Laguna Lake and Manila Bay.

Water Quality Trading

Water quality trading is a market-based approach in which point sources with regulatory requirements to reduce discharges of a given pollutant can buy credits from other sources, either a regulated source or an unregulated one such as a farm. The nonpoint source reductions are frequently less costly to achieve, allowing the point source to meet its regulatory requirements at lower cost than it would have if it upgraded its facilities and reduce the overall societal costs of restoring surface waters.

Nutrient trading is worth investigating as a useful tool in Manila Bay restoration efforts. For it to be used successfully, five conditions must be met.

1. Strict watershed caps are set for Total Nitrogen (TN) and Total Phosphorus (TP) and the caps are allocated to sectors and sources.
2. The domestic and industrial wastewater sectors are given regulatory requirements to reduce their discharged TN and TP loads consistent with the cap allocations.
3. Agriculture and/or other unregulated nonpoint sources are a significant source of TN and TP loads to Manila Bay.
4. Reductions in loads from agriculture and/or other unregulated nonpoint sources are achievable.
5. Nonpoint source reductions are less costly than point source ones.

The first step in evaluating the potential value of nutrient trading for Manila Bay would be to determine whether the five conditions are in place or will be in the near future.

The Role of Wastewater

While the Coastal Strategy, Operational Plan, and mandamus address all causes of Manila Bay's degradation, there seems to be a perception among many that perhaps wastewater is the only important sector and other sectors do not really need to be addressed. This may or may not be true, but actions should not be based on this assumption. The necessary monitoring and modeling must be done to determine if it is true before any plans are finalized.

There is little doubt that improving wastewater collection and treatment is needed. The discharge of untreated sewage should be eliminated as soon as possible to the maximum feasible extent. Further, WRI believes that it is likely that tertiary treatment for nutrient removal will be required at the wastewater treatment plants. This is especially true if wastewater is the predominate cause of Manila Bay eutrophication.

The Role of Agriculture

There has been little discussion of the potential contribution of agriculture to Manila Bay's eutrophication. This may be due to an assumption that agriculture is not making a significant contribution to the problems. If so, the assumption is premature at best and questionable at worst. Globally, agriculture is the largest source of nutrients to major water bodies suffering from eutrophication and its contribution to Manila Bay must be assessed. Even if wastewater is the dominate cause, it is possible that important gains can be made in the agricultural sector relatively quickly through actions such as better manure management and improved fertilizer practices.

If there is little or no monitoring data on agricultural nutrient runoff in the Bay, monitoring nitrogen and phosphorus fluxes at stream and river outlets to the Bay in order to estimate delivered loads could provide some insight into this question in a relatively short amount of time.

1. EUTROPHICATION AND MANILA BAY

The degradation of major water bodies is rapidly increasing around the world. Hundreds of coastal areas, marine embayments, and tidal estuaries are experiencing serious declines in water quality and ecological health. According to a recent report by the World Resources Institute:

> *"One of the leading causes of water quality impairment around the world is eutrophication, or the over-enrichment of water by nutrients such as nitrogen (N) and phosphorus (P). Eutrophication can lead to a number of symptoms that are harmful to freshwater and marine ecosystems. Increased nutrients can cause phytoplankton and macroalgae blooms, which can block light and lead to a loss of subaquatic vegetation (SAV). The imbalance in nutrient ratios can begin to change the benthic (bottom-dwelling) community structure by creating conditions that favor nuisance or toxic algae. Eventually, species diversity can be reduced and lead to systems dominated by gelatinous organisms such as jellyfish" (Selman and Greenhalgh, 2007).*

Eutrophication can have a multitude of negative impacts. It can result in large areas of hypoxia (very low dissolved oxygen) known as "dead zones," which can result in fish kills, toxic algae blooms, or ecosystem collapse. These environmental degradations in turn have adverse economic, social, health, and aesthetic impacts that harm humans. Most current dead zones occur seasonally but can become permanent if nutrient loads continue to increase.

Manila Bay is experiencing increasing degradation and eutrophication with many of the negative impacts on local populations described above.

1.1. Manila Bay Restoration and Protection Efforts

Manila Bay Environmental Management Project

Coordinated efforts to restore Manila Bay began in 2000 with a series of stakeholder meetings that eventually led to the establishment of the Manila Bay Environmental Management Project (MBEMP). This project is a local component of Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), with funding from the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP). The Department of Environment and Natural Resources (DENR) is the lead Philippine agency for the project.

Manila Bay Coastal Strategy

In 2001, the Program Management Office of the MBEMP released the Manila Bay Coastal Strategy, prepared in partnership with a wide variety of stakeholders including national, regional, and local government agencies; academe; civil society; the private sector; and religious organizations; with technical and logistic support provided by PEMSEA (MBEMP, 2001).

The Coastal Strategy broadly described the natural and human characteristics of the Manila Bay coastal region, and its historical, social, economic, and ecological value to the region and to the Philippines. It provided a detailed inventory of the risks to Manila Bay and the challenges of overcoming them. It set five major goals, each supported by specific objectives and action programs. The major goals are:

- Protect human welfare and the ecological, historical, cultural and economic features of Manila Bay for the benefit and security of present and future generations;
- Mitigate environmental risks that occur as a consequence of human activities in Manila Bay coastal areas and the surrounding watersheds;
- Develop areas and opportunities in Manila Bay in consonance with environmental goals, policies and plans, thereby striking a balance between economic development and environmental management;
- Communicate with stakeholders regarding their rights and responsibilities, and issues concerning the coastal and marine environment, thereby ensuring their involvement and active participation in the development and implementation of environmental management programs; and
- Direct the formulation and implementation of policies and institutional mechanisms to achieve sustainable development in Manila Bay through interagency and intersectoral partnerships at national and local levels.

The objectives and action programs address the broad range of actions needed to achieve these five major goals, making the Coastal Strategy an ambitious framework for the institutional, political, technical, regulatory, economic, social, environmental, and sustainability reforms that are needed.

Operational Plan for the Manila Bay Coastal Strategy

The MBEMP followed up the Coastal Strategy with the release of the Operational Plan for the Manila Bay Coastal Strategy (OPMBCS) in 2005 (MBEMP, 2005). The Operational Plan translated the strategies and action programs called for by the Coastal Strategy into action plans and programs in three overarching areas: Partnership and Governance; Water Pollution; and Over-exploitation of Resources and Degradation of Habitats and Historical, Cultural, Religious, Archeological and Unique Geological Sites. It set measurable targets, timeframes, budgetary requirements, and implementing arrangements (responsible agency/sector/partner, and enabling policies and laws). It also contained financing strategies, monitoring and evaluation procedures, and communication, information dissemination, and education strategies.

The desired short-term outcomes of the OPMBCS are:

- Endorsement of the Operational Plan by national and local levels of government, the private sector, civil society, donors, financial institutions, and international agencies and organizations;
- Adoption of the Operational Plan by the Regional Development Councils, and the National Economic Development Authority for incorporation into the Medium-Term Philippine Development Plan; and
- Mobilization of funds from national agencies and local government units, the private sector, NGOs, and external sources (e.g., donor agencies, international financing institutions, foundations, etc.).

The desired long-term outcome is the restoration and protection of Manila Bay and all of the ecosystem services and value it provides to the region and the Philippines.

Philippines Supreme Court Mandamus

Legal efforts to restore MB began in 1999 when Concerned Citizens of Manila Bay filed a complaint before a Regional Trial Court (RTC) against several government agencies asserting that they were negligent in allowing the water quality of Manila Bay to fall below the allowable standards set by law. The RTC ruled in favor of the respondents. The ruling stated, in part:

> "...finding merit in the complaint, judgment is hereby rendered ordering the above named defendant-government agencies, jointly and solidarily, to clean up and rehabilitate Manila Bay and restore its waters to SB classification to make it fit for swimming, skin-diving and other forms of contact recreation."

It went on to direct the ten government defendant agencies to undertake specific actions within their purview to restore Manila Bay. These actions included:

- Provision of sewage treatment;
- Management and proper disposal of garbage, solid waste, and toxic and hazardous wastes;
- Control of discharges from ships and docking facilities;
- Revitalization of Manila Bay marine life;
- Budgeting resources for the clean-up;
- Removal of debris from Manila Bay;
- Management of septic systems and disposal of septic sludge;
- Elimination of illegal fishing; and
- Public education.

This decision was upheld by the Court of Appeals in 2005 and the Supreme Court of the Republic of the Philippines in 2011. The Supreme Court issued a 'Continuing mandamus' directing the government agencies to undertake the actions listed above and to provide quarterly reports to the Supreme Court on their planning and actions to comply with the mandamus.

The required actions closely parallel many of those contained in the Coastal Strategy and Operational Plan.

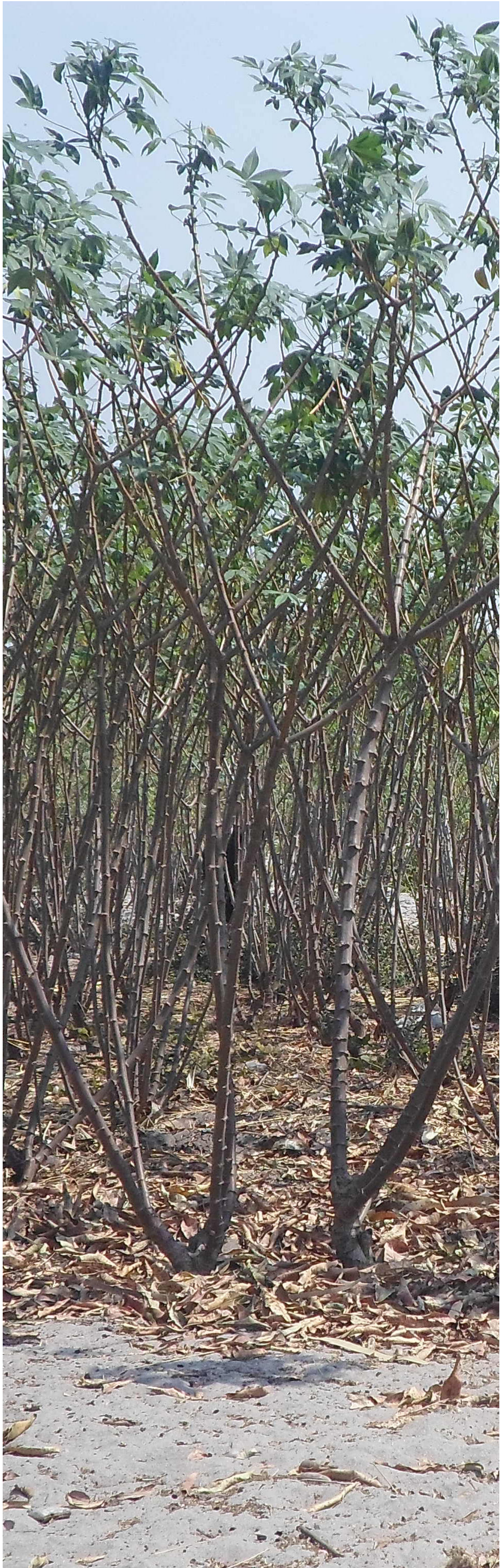
1.2 Purpose of this Report

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), with funding from UNEP/GEF, is providing technical and logistic support to the Manila Bay Environmental Management Project (MBEMP). As part of this technical report, PEMSEA has asked the World Resources Institute (WRI) to research international efforts to restore and protect major water bodies and to provide information on relevant case studies, successes and failures, and lessons learned, with an emphasis on nutrient control policies for urban and agricultural sectors. Drawing upon this and past research, PEMSEA desires WRI to identify the types of policy options that can be used to address pollution from various sectors. Policies can include tax- based, incentive-based, educational, regulatory, etc. ones. WRI also provides recommendations for next steps in creating a comprehensive watershed-based strategy for improving water quality in Manila Bay.

1.3 Contents of this Report

The contents of this report are:

- Necessary Elements for Effective Water Quality Management Strategies – An International Overview;
- The International Experience – Successes and Failures; and
- Recommendations for the Manila Bay Management Strategy.



2. NECESSARY ELEMENTS FOR EFFECTIVE WATER QUALITY MANAGEMENT STRATEGIES—AN INTERNATIONAL OVERVIEW

2.1 Introduction

When major water bodies such as Manila Bay undergo degradation, it is due to multiple pollutants from a variety of sources. This is well-illustrated by the information on Manila Bay contained in the Introduction. The various pollutants and their sources, and other causes of degradation, cannot be addressed in isolation. Efforts to reduce pollution discharges or impacts from any one source must be part of a larger, more holistic strategy and framework that provides a scientific basis for effective actions, the necessary regulatory requirements, and voluntary components where regulatory requirements are not possible or wise. Also needed are the flexibility to apply cost-effective approaches where beneficial, and public understanding and involvement. Any strategy must be cognizant of and adjusted to the technical, economic, social, and political realities of the country or region where it is being applied.

Following is an inventory of international frameworks and policy approaches for controlling water pollution and restoring major water bodies.

2.2 Necessary Elements for Effective Water Quality Management Strategies

The international inventory is organized around four general elements of water quality management, widely considered to be critical to the success of any water quality management framework. They are:

- A science-based holistic approach;
- Legislative and regulatory components;
- Voluntary components for nonpoint sources; and
- Economic policy instruments for nonpoint source pollution control.

Two additional elements are extremely important as well. They are:

- Public understanding and involvement; and
- Flexibility and adaptation.

This section describes these framework elements and illustrates them using examples from around the world.

2.3 Science-based Holistic Approach

A sound scientific basis and a holistic approach are needed if there is to be any realistic chance of restoring and protecting a major water body. Without them, any water quality management strategy would be piecemeal and guesswork. The effort must start with the collection of sufficient data to understand the sources and magnitude of pollution loadings and the impact of those loads to the water body. With sufficient data, predictive models can be developed to assess the water quality and ecological responses to reduced pollutant loads in order to determine the maximum pollutant loads that would enable the water body to be free of water quality impairments that would interfere with its desired uses. The determination of the maximum allowable loads in essence establishes a pollution budget for the water body. Pollution control scenarios can then be developed and evaluated using a number of criteria including environmental, economic, and social impacts, culminating in an allocation of the allowable pollution loads to the various sources, the assignment of pollution reduction responsibilities, and the development of implementation plans to achieve the reductions.

Tools and Analytical Frameworks for Evaluation and Decision-support

The tools and analytical frameworks that are needed are:

- Water quality monitoring programs;
- Pollutant source identification and loading measurement;
- Assessment methodologies;
- Predictive water quality and loading models; and
- Load allocation methodologies.

The Chesapeake Bay restoration effort in the United States illustrates the development and application of these elements.

Water Quality and Pollution Source Monitoring

A sound, science-based strategy begins with the design and implementation of a monitoring system to collect data on water quality parameters, physical characteristics, and biology. The monitoring has three objectives:

- Characterize the baseline water quality conditions;

- Detect trends in water quality indicators; and
- Increase the understanding of ecosystem process and factors affecting water quality and living resources.

Monitoring data must be collected for a sufficient period of time to capture the variability in water quality and long-term trends as well as to enable proper calibration and verification of the predictive models that will be used to evaluate alternate management scenarios.

Data must also be collected on the sources, locations, and magnitudes of pollutants entering the water body. This includes runoff from agricultural areas, urban stormwater, municipal wastewater treatment plant discharges, direct and indirect industrial discharges, septic tanks, atmospheric deposition, and release of pollutants from bottom sediments of the water body. Tributary rivers and streams must be monitored to determine the pollutant loads they deliver to the water body.

The Chesapeake Bay on the east coast of the United States is a large tidal estuary similar in many respects to Manila Bay. An extensive monitoring program was created in 1984 during the early stages of the efforts to restore and protect the Bay.

In addition to accomplishing the three objectives listed above, the watershed monitoring networks have accomplished many more objectives in the past 26 years, including the following:

- Identifying eutrophication as the primary cause of the decline in submerged aquatic vegetation (SAV);
- Providing sufficient and diverse data to support the development and implementation of refined water quality standards and discharge limits, and support government regulatory actions such as the establishment of Total Maximum Daily Loads (TMDL);
- Supporting geographic and pollutant source specific targeted implementation for the most cost effective and efficient management actions; and
- Supporting decision-makers' needs for the Bay TMDL process with high-quality data underlying the Chesapeake Bay watershed and tidal water quality, sediment transport, biological resource, and filter feeder models' development, calibration, verification and management application.

The program included monitoring of tributary rivers and streams, Bay tidal segments, shallow waters, benthic organisms, phytoplankton, zooplankton, submerged aquatic vegetation, and fisheries. The list of sampled parameters is very long and includes all of the parameters needed to construct, calibrate and verify the water quality model and all of its physical, chemical, and biological components (USGS, 2007).

Predictive Models

Modeling for watershed-based water quality management has two general objectives: (1) predicting the pollution inputs to the water body from point and nonpoint sources, and (2) predicting the response of the water body to the input of these pollutants.

The model used for the first objective is referred to as a watershed model. Using the pollutant load inputs from the monitoring data, it simulates pollutant fate and transport mechanism on the land surfaces and in rivers and streams tributary to the water body. It is also used to model pollutant loads delivered to the water body under different management scenarios. Air deposition models can be linked to the watershed model.

The water-body response model for a large water body is generally referred to as simply the water quality model. Water quality models can range from simple to very complex, depending on the nature of the water body, the availability of monitoring data, and the resources available for model development and ongoing modeling.

The most comprehensive and sophisticated model in the world is the Chesapeake Bay water quality model. It consists of a number of linked sub-models: hydrodynamics; water column chemical and biological processes; sediment transport; benthic uptake and release; macro invertebrates; and submerged aquatic vegetation. This comprehensiveness enabled the U.S. Environmental Protection Agency (EPA) to develop and implement sophisticated water quality standards for the Bay; assess pollutant loading delivered to the Bay from a 64,000 square miles (165,759.24 km^2) watershed (and even larger airshed); model the water quality and biological response of the Bay to the pollutant loads; establish maximum allowable loads of nitrogen, phosphorus, and sediment to the Bay; evaluate a multitude of management scenarios dealing with point source and nonpoint source discharges and atmospheric emissions; and allocate the allowable loads to major tributaries, states, and sectors.

It is critical to keep in mind that water quality and watershed models are imperfect tools and are never free of a significant degree of uncertainty regarding their predictive abilities. All aspects of water quality management share this problem, from questions about the quality and representativeness of monitoring data to limited scientific understanding of natural processes, especially biological ones. Because of this, modeling tools must be used carefully and prudently, making water quality management as much an art as a science. This necessitates an adaptive management approach, as discussed below.

Determination of Allowable Pollution Loads

Once the predictive models have established the maximum allowable pollutant load to a water body, the load can be allocated to the various sources. Uncontrollable loads, such as nutrient runoff from forested areas, are first accounted for, then the allocation of remaining load can be made to the various sectors. The allocation process is not a simple one; it must take into account natural watershed boundaries, political boundaries, sector-specific issues, economic, social, technical, and environmental considerations, with many trade-offs involved. Equity issues will also be at the forefront. This makes it a social and political process as least as much as a technical one. As such, a large variety of stakeholders ideally should be involved in the process.

Examples of allocation processes from the U.S.A. and Europe are presented below in Section 2.4.

2.4 Legislative and Regulatory Components

It is difficult to envision any real success for water quality management efforts if they are not driven and supported in some degree by legislative and regulatory requirements. While there are a large number of possible requirements that could be discussed, this section will focus on those that are the most critical to success. They fall into two general categories: adopting mandatory environmental standards and assigning responsibilities for water quality management activities.

Environmental Standards

There are four types of environmental standards applicable to water quality can be identified:

- Water quality standards;
- Pollution caps and watershed loading targets;
- Discharge limits; and
- Practice-based standards for agriculture and aquaculture.

Water Quality Standards

A necessary first step in managing water quality is the establishment of water quality goals, generally expressed as water uses to be protected, and the numeric criteria that are needed to ensure that the uses are possible. These criteria form the scientific and legal basis for all water quality planning and management activities, as well as any regulatory requirements placed on pollution sources.

The European Union established a broad, comprehensive framework for water quality management by its 27 member nations when it issued the EU Water Framework Directive (WFD) in 2000 (European Union, 2000). The WFD contained all of the critical elements for water quality management identified above and is binding on EU members. Among its elements is the establishment of water quality goals and standards. The WFD states: "Waters must achieve good ecological and chemical status, to protect human health, water supply, natural ecosystems and biodiversity." It defined five levels for ecological status for water bodies: high, good, moderate, poor and bad. Each status is defined by the "abundance of aquatic flora and fish fauna, the availability of nutrients, and aspects like salinity, temperature and pollution by chemical pollutants." Physical and morphological features of water bodies are also taken into account. For chemical pollutants, the status of a water body is defined by 41 chemical pollutants "of high concern."

In the United States, the Clean Water Act, first passed in 1972 and significantly amended in 1987, directed the U.S. Environmental Protection Agency (USEPA) to promulgate water quality standards necessary to achieve the Act's fundamental goal of making the waters of the United States "fishable and swimmable". As a result of this requirement, each state has adopted water quality standards that are comprised of designated uses assigned to water bodies, and the criteria needed to protect those uses, Examples of designated uses include: recreation (primary and secondary body contact), protection and propagation of fish and wildlife, public water supply, and agricultural and industrial water supply.

A number of numeric criteria have been adopted in the U.S., such as minimum dissolved oxygen levels, pH ranges, turbidity, and various toxic substances. Non-specific narrative criteria such as a prohibition of substances that "are unsightly" and "create a nuisance" have also been adopted, giving regulatory authorities flexibility in controlling discharges.

Allocation of Allowable Pollution Loads

European Union

The EU Nitrate Directive issued in 1991 (EU, 1991a) is a sub-directive of the WFD. Its goal is to "protect water quality across Europe by preventing nitrates from agricultural practices polluting ground and surface waters and promoting the use of good farming practices." It does not directly require watershed loading caps but requires member states to identify territories that drain to waters that are susceptible to high nitrate levels or eutrophication. These territories are called Nitrate Vulnerable Zones (NVZ) and member states are required to draw up Action Programs that reduce nitrate loadings to acceptable levels.

The approach to watershed caps taken by the EU in the WFD is to establish what it termed a "combined approach" (Bloch, 2004). First, pollution is limited at the source by imposing technology-based emission controls on wastewater discharges and some agricultural practices such as fertilizer application. For water bodies where these limits are inadequate on their own to meet water quality objectives, additional limits based on water-quality responses are imposed. This requires establishing a pollutant budget for the water body.

United States

In the United States, the Clean Water Act (CWA) requires the adoption of a "Total Maximum Daily Load" (TMDL) for a pollutant impairing a water body. The objective of a TMDL, according to the USEPA "is to allocate allowable loads among different pollutant sources so that the appropriate control actions can be taken and water quality standards achieved..." (USEPA, 1991). A TMDL usually contains (Jones, et al., 2005):

- A statement of the water quality problem;
- An analysis to determine the level of pollutant loading that would achieve water quality standards; and
- An allocation of the allowable load to the various sources in the watershed, both point and nonpoint, including an allowance for future growth and a margin of safety.

Upon approval, a TMDL becomes a binding regulatory requirement and any discharge permits issued in the watershed must be consistent with the TMDL. It is important to note that the TMDL must address nonpoint sources such as agriculture and assign a load allocation for to this category. However, the CWA gives the federal government no regulatory authority over nonpoint sources; the power to regulate them, agriculture in particular, is left to the states. Nevertheless, an adopted TMDL is a federally-enforceable regulatory requirement that a state takes action to ensure that the nonpoint source load allocation is achievable and met.

For the Chesapeake Bay, the full suite of modeling tools was used to determine the total allowable loads of nitrogen and phosphorus to the mainstream of the Bay. The Bay was divided into 92 tidal segments and individual nitrogen and phosphorus load limits were determined for each of the 92 segments. Those load limits were then allocated to the land areas draining to each of the 92 segments.

Table 1 shows the current total nitrogen and phosphorus loads to the Bay (2009) and also the TMDL, which is the sum of the 92 segment allocations.

Table 1:
Chesapeake Bay TMDL Loads and Current Nitrogen and Phosphorus Loads.

Nutrient	TMDL million kg/Year	Current Load (2009) million kg/Year
Nitrogen	91.7	112.9
Phosphorus	5.7	7.5

These allocations were then sub-divided among the Chesapeake Bay states of Pennsylvania, Maryland, Virginia, West Virginia, Delaware, New York, and the District of Columbia. Achieving these allocations in each land area is now a regulatory requirement, with the states having primary responsibility for achieving and maintaining the load caps. They have all developed Watershed Implementation Plans that describe how each state intends to achieve the caps in its segments and maintain them as growth and economic development continues. This will involve sub-allocating the allowable loads to the wastewater, agricultural and stormwater sectors.

Discharge Limits for Point Sources

Once adopted, watershed loading targets such as NVZ Action Plans in the EU and TMDLs in the United States establish the basis for setting discharge allowances or effluent limits for municipal and industrial wastewater treatment plants. In the U.S., municipal stormwater discharges in cities above a certain size are defined as point sources in the CWA and the cities are given stormwater discharge permits that contain requirements for controlling the discharge of pollutants. These requirements have in the past been comprised of a requirement to "control the discharge of pollutants to the "Maximum Extent Practicable (MEP)" as well as programmatic measures such as street sweeping. EPA is now moving toward establishing quantitative requirements and possibly numeric limits on the discharge of pollutants.

Large animal feeding operations in the U.S. are defined as point sources as well, and required by the CWA to have discharge permits. In theory, Concentrated Animal Feeding Operations (CAFOs) are prohibited from discharging pollutants to surface waters.

The approaches to controlling agricultural nonpoint source pollution have largely been voluntary in nature. In both the U.S. and Europe however, some regulatory requirements have been placed on agriculture. In the U.S., many states have required farms applying chemical or organic fertilizers to crops to prepare Nutrient Management Plans (NMP) prepared by certified experts. The NMPs are customized for each farm and describe the recommended nutrient application practices for that farm.

In the EU, the NSZ Action Programs set mandatory requirements for some agricultural practices. For example, land application of livestock manure is limited in NVZs to 170 kg N/ha per year by the Nitrate Directive (EU, 1991b). There are additional requirements for the timing of fertilizer application, the use of fertilizer on slopes or near water bodies, and the storage of animal manure. Cyprus, Hungary and Spain go further by coupling the use of fertilizer with regulation of irrigation systems (EU, 2010).

Mandatory Practice-based Standards for Agriculture

While the approaches to controlling agricultural nonpoint source pollution have largely been voluntary in nature, some regulatory requirements have been placed on agriculture. Many U.S. states have required farms applying chemical or organic fertilizers to crops to have NMPs prepared by certified experts. The NMPs are customized for each farm and describe the recommended nutrient application practices for that farm. There is no requirement however, that these plans be implemented and there is no inspection to ascertain whether these plans are being followed.

Phosphate Detergent Bans

Phosphate detergent bans have become common in developed countries over the last 40 years. The bans were designed to help prevent eutrophication of lakes and coastal areas. Following is a summary of these bans by region.

- **Europe** – Italy introduced a restriction of 4 percent phosphate content in household detergents in 1985.

This was followed by regulatory bans on phosphates in household detergents in Switzerland and Norway and subsequently Austria in 1994 (Köhler, 2006). In 2013, the European Union banned the use of phosphates and limited the content of other phosphorous-containing compounds in consumer laundry detergents. A standard measure of laundry detergent cannot contain more than 0.5 grams of phosphorus. Similar restrictions will apply to consumer automatic dishwasher detergents beginning in 2017. This will require a total phosphorus content of less than 0.3 grams of phosphorus per standard dosage (European Parliament, 2011).

- **North America** – In 1970, the American detergent industry voluntarily agreed to limit phosphate in detergents to 8.7 percent by weight as phosphorus. Twenty-six U.S. states have implemented phosphate detergent bans for household laundry detergents since the early 1990s. By 2010, 26 states have applied phosphate bans to consumer dishwashing detergents. Canada has regulated phosphate levels in detergents since the 1970s. A phosphorus limit of 8.7 percent was established in 1970 and was subsequently dropped to 2.2% in December 1972 (Litke, 1996).

- **South America** –The Brazilian government imposed a gradual reduction of phosphorus in detergent formulations, from a maximum level of 15.5 percent in 2005 to 12.5 percent in 2008 (Phosphate Facts, 2009). Paraguay banned domestic production and imports of sodium tripolyphosphate-based detergents that represented 95 percent of the market.

- **Asia** –Japan banned the use of phosphates in laundry detergent in 1984 (Johnson, 1996). RO Korea did so as well in the late 1980s (Phosphate Facts, 2009). In PR China, under the provisions on Protecting Drinking Water Sources of Water Pollution Prevention and Control Law, the State Council and local governments can prohibit or restrict the use of phosphates in detergents in protected drinking water source areas. Major coastal provinces, including Guangdong, Liaoning, and Shandong, have banned the sales and use of laundry and dishwashing detergent containing more than 1.1 percent phosphate.

Detergent manufacturers in the U.S. and Europe initially strongly resisted the ban. They made three main arguments against it:

1. It is hard to find alternative ingredients to replace phosphates. They served as a "builder" to improve the detergent's cleaning efficiency. The detergent industry stated that it would take several ingredients to try to replace what phosphate does, and the requirements would vary for powdered products and gels and those that mix the two (Lindeman, 2009). Some soap makers claimed that it would be impossible to remove phosphate ingredient from their products.

2. Phosphate-free detergents do not work effectively, especially in hardwater areas.

The dishwashing detergent manufacturers stated that in areas with phosphate bans, customers complain that the phosphate-free detergents do not work as effectively as the phosphate products.

3. Phosphates in detergent are not the main cause of eutrophication. The U.S. Soap and Detergent Association argued that most of the phosphates in the environment come from other sources, such as farm runoff, hence the use of phosphate detergents is not the main reason causing eutrophication (Lindeman, 2009).

In Europe, CEEP, west Europe's phosphate industry's joint research association, argued that phosphates are the only recyclable detergent ingredient which can be recovered from sewage and recycled, either back into industrial products, or into food production; the use of other chemicals in detergents may leave residues on washed clothes and contribute to indoor air pollution, particularly with modern low-rinse-water washing machines; and that phosphate-free laundry detergents also result in increased aluminum content in sewage and sewage sludge (CEEP, 2007).

The detergent industry's attempts to prevent the bans in Europe and the U.S. largely failed. Predictably, the bans spurred innovation. Since the onset of the bans, which are now globally wide-spread, detergent manufactures have found substitutes for phosphates, including enzymes, sodium citrate and sodium carbonate. Some examples are:

- In the early 1990s, Procter & Gamble (P&G) voluntarily stopped using phosphates in laundry detergent sold in the U.S. It also removed phosphates from its detergents sold in the European market even before the European Union phosphate bans. In 2014, P&G announced that it plans to eliminate phosphates from all of its global laundry detergents within two years. Considering that P&G has a 25 percent share of the global detergent market, this will have wide-spread impact in developing countries that do not have phosphate detergent bans (Gies, 2014);

- In 2008, Colgate-Palmolive launched Palmolive eco+, which it described as "the first phosphate-free automatic dishwasher detergent available from a mass market brand in the U.S." (Lindeman, 2009); and

- Wal-Mart Stores, Inc. committed to reducing phosphates in laundry and automatic dishwasher detergents in the Americas region by 70 percent by 2011. This affects Puerto Rico, Mexico, Central America, Brazil and Argentina (Phosphate Facts, 2009).

Few studies have been done to ascertain the water quality benefits resulting from the phosphate detergent bans and of those, most were done in the 1980s during the contentious debates over implementing the bans. Two papers in particular make strong arguments that unless phosphate detergents contribute a large percentage of the phosphorus load to a receiving water, then a ban would have little impact on its trophic state (Maki, Porcella, & Wendt, 1984 and G. Fred Lee, 1986). However, these conclusions are limited in their general applicability because they assume a very high level of sewage collection and treatment and that septic systems are well maintained and hence discharge little phosphorus.

Additionally, and perhaps more importantly, this method of analyzing the water quality impacts of the loadings from a single source and concluding that it is too small to have a major impact is inconsistent with the current water quality management approach of analyzing a water body's response to a pollutant — establishing a watershed cap (the maximum allowable load) for the pollutant, and then allocating the cap to the various sources. The smaller sources, such as urban stormwater runoff, direct industrial discharges, and septic systems, do not escape allocations and required discharge reductions simply because other sources have much bigger loads. Reasons for this includes efficiency and cost-effectiveness, equity, and a lack of regulatory power over all sources. As an example, if the "too small to be worthwhile to reduce" principle were applied to the Chesapeake Bay nitrogen and phosphorus TMDL, municipal and wastewater treatment plants would not have had to implement any additional nutrient removal because the wastewater sector was contributing less than 20 percent of the loads to the Bay, with agriculture and air deposition both contributing far more. To regulators, however, wastewater treatment plants were the obvious starting point for reducing nutrient loads. Reasons were that:

- Their discharges are regulated under the Clean Water Act;
- There would be no uncertainty over how much reduction would actually be achieved, unlike nonpoint source reductions;
- Wastewater reductions could be achieved the quickest; and
- Equity, political, financial, and otherwise, demanded that all sectors contribute to the restoration of the Bay.

For these reasons, regulators regarded wastewater treatment plants as "low-hanging fruit" and they were the first to be required to reduce nutrient discharges.

The conclusions of these early studies are also not widely applicable in developing countries because of their assumptions about the levels of wastewater collection and treatment and septic systems. However, in areas such as Manila where signicant amounts of sewage are not collected and treated but instead directly enters ditches, streams and rivers flowing to Manila Bay, the phosphorus loads due to phosphate detergents could very well be significant. The implications of this are discussed in the recommendations section of this report.

Compliance and Enforcement Mechanisms

Mechanisms must be in place to ensure that regulatory requirements are being met, otherwise, they will be widely ignored. These mechanisms include monitoring of the discharges of regulated sources such as municipal and industrial wastewater treatment plants in order to determine compliance and an effective enforcement mechanism that can be used when noncompliances are found. The penalties levied in the event of noncompliance should be higher than the costs that the discharger avoided by discharging illegally.

2.5 Voluntary Programs for Agriculture

Globally, there are few efforts to regulate agricultural nonpoint source pollution and little political will to try and do so (Denmark is a major exception, as described below in Section 3.4.1.). Since it is not likely that widespread regulations that require farmers to change practices and behaviors can or will be implemented, ways must be found to persuade farmers to do so on a voluntary basis. Three types of voluntary programs aimed at reducing agriculture nonpoint pollution are in use in the U.S. and Europe. They are voluntary practice-based standards for farming; technical assistance for farmers, including environmental outreach and education; and subsidies for conservation practices, known as green payments.

Voluntary Practice-based Standards

Many farmers are willing or even want to manage their farms in an environmentally sound manner. A critical element to enable them to do so is for agricultural agencies and technical experts to develop standards for good agricultural practices, frequently referred to as best practices, that farmers can use if they want to. In the U.S., the National Resource Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA) have developed a large set of National Conservation Practice Standards that provide information on a wide range of conservation practices. Information provided includes reason for the conservation practice, where it is applicable, and the benefits it provides. The standards also contain minimum quality criteria for application of the practice (NRCS, 2012c).

Education and Outreach to Farmers

Farmers are frequently unaware of the environmental impacts of their farming practices, particularly if those impacts occur in distant water bodies. In a recent survey in the Chao Lake basin in Anhui Province, PR China, many farmers indicated that they would take steps to reduce the pollution runoff from their farms if they knew that it was harming the lake. While such a survey is not a reliable predictor of actual behavior changes, it does indicate that education programs that inform farmers about the impacts of farming on the local and downstream, rivers, lakes and coastal waters might result in some level of voluntary changes by farmers. Elements of such an education program should include providing information on the following:

- The connection between land and water quality and the ecological health of streams, rivers and lakes. The health can be expressed in terms of the ecosystem services that the water bodies provide to people, such as safe drinking water supply, and a productive fishery;
- Identification of phosphorus, nitrogen, COD and sediment as the important pollutants;
- The connection between farming practices and pollution loads;
- The things farmers can do to reduce pollutant loads from their farms;
- The benefits to the farmers for certain changes; and
- The technical and financial resources available to farmers to enable them to make changes.

Technical Assistance Programs

In the U.S., the federal and state governments have long histories of providing technical assistance to farmers. The National Resource Conservation Service (NRCS) of the USDA is the main federal agency providing farmers technical assistance. Among the voluntary programs it offers are:

Agricultural Management Assistance (AMA)

The AMA program provides financial and technical assistance to farmers for the incorporation of conservation practices to improve water management, water quality, and erosion control. This can include building water management or irrigation structures, planting trees for windbreaks or riparian buffers, integrated pest management, or transition to organic farming (NRCS, 2012a).

Conservation Technical Assistance (CTA)

The CTA program provides land owners with conservation technology and the means to keep their lands healthy and productive (NRCS, 2012b), Primary goals include:

- Reduce soil loss from erosion, and to solve soil, water quality, water conservation, air quality, and agricultural waste management problems;
- Enhance the quality of fish and wildlife habitat; and
- Improve the long-term sustainability of all lands, including cropland, forestland, grazing lands, coastal lands, and developed and/or developing lands.

The U.S. also has an extensive system of Conservation Districts, commonly known as Soil and Water Conservation Districts (SWCD). District staff provide farmers advice, information, technical assistance and tools to manage their lands and protect water resources. Part of the effectiveness of SWCDs is due to the fact that SWCD staff are generally members of the local community and frequently are farmers themselves. In addition, each SWCD is governed by a local Board of Directors drawn from the local community.

The U.S. Department of Agriculture also operates its extension service (NIFA, 2012), more commonly known as the Cooperative Extension Service (CES). The original mission of the CES was to facilitate the practical application of agricultural research and to provide instruction and demonstrations for farmers on improved practices and technologies. It has evolved to include a wide variety of communications and education for farmers and other rural residents. This is carried out largely by public state universities who provide the extension services in the state in which they are located, with USDA providing funding.

Cooperative extension services are not unique to the U.S. Most countries have similar extension services for farmers and rural populations.

Conservation Subsidy Programs

The provision of standards for best agricultural management practices (BMPs) and technical assistance to help farmers implement them would not accomplish much if farmers were not also provided financial assistance for their implementation. This is particularly true for structural BMP such as stream buffers or water control structures.

Many countries around the world have similar subsidy and incentive programs for protection of natural resources on agricultural lands.
A sampling of these programs includes the following:

- Belgium – Environment-related subsidies for farmers and subsidies for the collection of animal wastes;
- Denmark – Subsidies for ecological agriculture, environment-friendly agriculture, and stream restoration;
- Canada – Subsidies for conservation of soil and water courses;
- Netherlands – Support for the agriculture sector and fishing industry;
- United Kingdom –Grants for nitrate-sensitive areas;
- Switzerland – Subsidy for ecological livestock production and nature and landscape protection;
- European Union – Common Agricultural Policy provides payments to farmers who reduce fertilizer use, introduce organic farming measures, reduce grazing intensity, and promote biodiversity; and
- The USDA offers several programs that fund conservation practices that are voluntarily implemented by farmers and land owners.

Conservation subsidy programs are described in more detail in Section 2.6.

2.6 Economic Policy Instruments for Nonpoint Source Pollution Control

Policy instruments for controlling agricultural nonpoint source pollution can be grouped into four general categories:

- Agricultural taxes and fees
- Environmental cross-compliance
- Water quality trading programs
- Green payments to farmers
  - o Subsidies for conservation practices
  - o Payments for retirement of sensitive lands
  - o Payments for ecosystem services
  - o Cooperative agreements

This section briefly describes these instruments and their use around the world.

Agricultural Taxes and Fees

Environmental taxes, fees, and charges are widely used as economic instruments for environmental protection in Europe (EEA, 2005). They are not widely used in the agriculture sector however. The most frequent use is taxes or charges on agricultural inputs. Belgium Denmark, Finland, Norway and Sweden all tax pesticides.

The use of fertilizer taxes has decreased in Europe. Austria and Finland abolished their fertilizer tax due to competitive concerns when they joined the EU in 1994. Norway abolished its fertilizer tax in 2000 for the same reason. The Netherlands implemented a mineral accounting system known as MINAS in 1998 that required farmers to keep records of nitrogen and phosphorus inputs and outputs and levies were charged for "surplus" input (i.e., input in excess of crop needs). MINAS was repealed in 2006, however, because it was not consistent with the EU Nitrate Directive.

Environmental Cross-compliance Requirements

Environmental cross-compliance refers to environmental requirements placed on farmers who wish to enroll in agricultural support programs such as crop price supports. In order to be eligible for such programs, farmers must meet certain environmental requirements or specified performance levels. Environmental cross-compliance requirements are common in OECD and EU countries. They became mandatory for some EU member states in 2005 and will be phased in for the remaining member states by 2013.

In the U.S., cross-compliance requirements were introduced in farm-related legislation in 1985. This requirement was responsible for about one-third of the soil erosion reduction achieved in the U.S, between 1985 and 1996. However, while the requirement still exists, the benefits have faded away due to a lack of inspection and enforcement and the fact that the requirements only address erosion and not nutrients. A further problem is that there are no cross-compliance requirements for participation in the popular crop insurance program.

Conservation Subsidies (Green Payments)

In the United States, the three most important conservation subsidy programs are the Conservation Reserve Program, the Environmental Quality Incentives Program and the Conservation Stewardship Program.

Conservation Reserve Program (CRP) — This program originally focused on financial

Table 2:
An International Census of Active Payment for Ecosystem Services Programs.

Region	Active Programs
Asia (excluding PR China)	9
PR China	47
Africa	10
Europe	1
Latin America	36
North America	10
Total	*113*

incentives for the retirement of erodible or sensitive environmental lands. The scope of CRP has now expanded to include a broader range of incentives. It is augmented by several smaller programs such as the Wildlife Habitat Incentive Program, the Wetlands Reserve Program, and the Grassland Reserve Program. These reserve programs provide land owners with cost-share assistance and annual rental payments for eligible lands (FSA, 2012).

Environmental Quality Incentives Program (EQIP) — This is a voluntary program that provides financial and technical assistance to farmers for the implementation of conservation practices on agricultural and forest lands to improve and protect natural resources such as soil, water, flora and fauna, and air quality. It can also help farmers meet federal, state and local environmental requirements (NRCS, 2012c).

Conservation Stewardship Program (CSP) — This is a voluntary program that was introduced in 2008. It encourages farmers to undertake conservation activities by providing annual payments for environmental benefits produced by the farmer. The larger the benefit, the higher the payment (NRCS, 2012c).

As noted in Section 3.2, there are a number of similar conservation subsidy programs for agriculture around the world.

Payments for Ecosystem Services

Ecosystem services are the services that ecosystems provide to humans, such as food, fiber, water, and timber. Payments for ecosystem service programs involve paying landowners to preserve or restore ecosystems on their lands that provide these services. Programs for water-related services are known as Payment for Watershed Services (PWS) and have the goal of changing behaviors that negatively impact water quality and quantity by making payments to landowners that encourage conservation of land and best management practices, usually on agricultural and forested lands. Forests and agriculture can greatly affect watershed health in a variety of ways, so the goal of PWS schemes is to increase sustainable practices on these lands. Most active PES programs around the world are for the purpose of protecting watersheds and forests or both. As can be seen in **Table 2**, there are not a large number of PES programs globally, with interest being highest in PR China and South America.

There is clearly overlap between agricultural conservation subsidies and the concept of payments for ecosystem services. PES programs perhaps differ because they can broaden the pool of landowners and funders and provide greater flexibility than the highly-structured government subsidy programs.

Water Quality Trading Programs

Water quality trading programs are under development in the U.S. and a few other countries. They are a market-based approach in which point sources with regulatory requirements to reduce discharges of a given pollutant can buy credits from another source, either a regulated source or an unregulated source such as a farm. The nonpoint source reductions are frequently less costly to achieve, allowing the point source to meet its regulatory requirements at lower cost than it would have if it upgraded its facilities. Other potential benefits of a trading program involving nonpoint sources include creating financial incentives for farmers to reduce their nutrient pollution and improving the water quality of lakes, rivers and streams.

Most trading program development has been in the U.S. and the trading programs have almost all been for nutrients. Large-scale nutrient trading programs are being developed and implemented for the Chesapeake Bay and Ohio River watersheds. These trading programs cover large geographic areas and involve multiple states. Trading programs have also been implemented or are under development in Canada, Australia, New Zealand, Sweden, and PR China (Selman, et al., 2009b).

Trading programs alone cannot achieve water quality goals, so they should not be regarded as a panacea. Pollutant caps achieve water quality goals and trading programs are a way of providing flexibility and lower cost in meeting those caps. They must be carefully designed, however, or they could do more harm than good. There are many issues involved in designing a trading program; the following criteria for trading program design have been established to ensure environmental integrity. They are:

- **Additionality** – Pollution load reductions that are produced to be sold as credits must be in addition to reductions that would have occurred anyway. Without additionality, there would be no net environmental benefit;
- **Equivalence** – Pollutant loads being traded must have equivalent environmental impact. The location of discharges is important in water quality trading programs and trading programs must account for difference in impacts of the pollutant discharges due to location; and
- **Compliance and Enforcement.** There must be mechanisms in place to ensure that trading program requirements and rules are being met by credit buyers and sellers.

2.7 Public Education and Participation

Educating the public about the ecological degradation of water bodies and the loss of ecosystem services and providing the public meaningful opportunities to provide input into planning and management decisions are both critical elements for successful restoration efforts. This is especially true when large and highly-valued water bodies such as Manila Bay are the target, and management decisions have significant social, economic, and environmental issues and impacts.

Public understanding and participation provide a number or benefits, including:

- The public, civil society, business and industry, and academe can all provide valuable information and input to the decision-making process;
- Better public understanding of the problem, alternative solutions, and decisionmaking process;
- Management decisions will reflect public interests and values and be better understood by the public, ultimately increasing public acceptance of them and making them more implementable;
- Increased public willingness to devote financial and other resources to the restoration efforts; and
- Better outcomes in general.

The major force for restoring Manila Bay, the Philippine Supreme Court mandamus, is itself a direct result of an act by members of the public — the 1999 lawsuit against ten executive departments and agencies for neglecting to perform the duties of their respective offices, filed by Concerned Residents of Manila Bay, a group of fourteen young people.

Even in a successful public participation program, only a relatively small number of citizens and other stakeholders are likely to actively participate. This does not mean though, that public education efforts should be directed only to those actively involved. Widespread public and political support is needed and this cannot be acquired without effective public education efforts.

"Using the best tools and data available, we should make best estimates and take action, recognizing that the decision and action may not be final."

2.8. Flexibility and Adaptation

Water-quality management is accompanied every step of the way by uncertainty. Some feel that this uncertainty justifies the use of very conservative and strict regulatory approaches, while others call for more "sound science," i.e., less uncertainty in the setting of regulatory requirements, lest scarce resources be wasted in implementing needless or ineffective requirements. At their extremes, neither of these two opposing philosophies are very useful in attempting to improve water quality in the real world of resource limitations and unavoidable uncertainty.

A pragmatic approach to the water quality management uncertainty is being taken in the U.S. TMDL program. TMDLs contain provisions for follow-up monitoring, evaluation, and potential revision, in order to "allow for an iterative (or adaptive or phased) approach in cases of uncertainty or lack of success in achieving standards" (EPA, 1998).

Freedman termed this concept "adaptive watershed management" and described it as:

> *"Using the best tools and data available, we should make best estimates and take action, recognizing that the decision and action may not be final. If we work to explicitly define the range of uncertainty in our analysis, we can act within that range. Then if, as part of the TMDL, we monitor progress and later adapt our actions, we can continue to progress toward clean water." (Freedman, 2001).*

The U.S. National Research Council termed it "adaptive implementation" and considered it nothing less than the incorporation of the scientific method into the TMDL process:

> *"It is a process of taking actions of limited scope commensurate with available data and information to continuously improve our understanding of a problem and its solutions, while at the same time making progress toward attaining a water quality standard. Plans for future regulatory rules and public spending should be tentative commitments subject to revision as we learn how the system responds to actions taken early on." (NRC, 2001 p.90).*

A key principle to remember in the initial stages of an effort to restore a major water body is that the adaptive management approach means that things do not have to be perfect in order to proceed. Nor should far-reaching or expensive requirements be mandated in the face of excessive uncertainty. The key is to work continuously to improve scientific understanding as steady progress is made toward water quality goals.

In summary, adaptive management involves the following steps:

1. Assess the problem;
2. Design solutions;
3. Implement the solutions;
4. Monitor the effects of the solutions;
5. Evaluate the results;
6. Make changes to the solutions to improve the results; and
7. Return to step 1 and repeat the process.

3. THE INTERNATIONAL EXPERIENCE — SUCCESSES AND FAILURES

This assessment of successes and failures deals exclusively with agricultural nonpoint source nutrient pollution. Major restoration efforts in Europe and the U.S. have started with increased controls for wastewater treatment discharges. This has not been enough in most cases because agriculture is the dominant source of nutrient pollution. Hence, the success or failure of the EU's Nitrate Directive or the U.S.' Chesapeake Bay Program ultimately depends upon reducing nutrient loadings coming from agriculture.

3.1 Policy Successes and Failures

Following is an assessment of how successful the European Union has been in controlling nutrient pollution and restoring the water quality of critical water bodies.

European Union

In general, the EU countries have not achieved much success in meeting the goals of the Nitrate Directive and its timelines will not be met. Reasons for this failure (Nimmo Smith, et al., 2007), include:

- Inadequate scientific understanding of the link between agricultural activities and the water quality of surface waters;
- Vague and unclear requirements in the Directive;
- The global economic slow-down;
- Unwillingness to regulate agricultural activities;
- Adoption of fertilizer goals based on economic, not environmental optimums; and
- Lack of belief by farmers that they are causing water quality problems.

Some progress has been asserted in Eastern Europe, notably the Danube River Basin. Instream nutrient concentrations have declined and water quality has improved somewhat. However, the only real changes that have occurred have been the collapse of high-input, industrial-scale Soviet farming with replacement by small-scale, low-input farming, as well as the global economic slow-down. It is likely that these are the causes of the improved water quality, and not any water quality management program (Simpson, 2013). As Eastern Europe recovers and continues to develop, water quality is likely to worsen again.

Denmark is a notable exception, however, and has had more success than any other country in the world in controlling agricultural nutrient pollution. The reasons for this (Nimmo Smith, et al., 2007) are:

- Implementation of the Nitrates Directive was rapid;
- Denmark chose to address environmental water quality in addition to drinking water quality, unlike some EU countries;

- Denmark designated the whole country as a Nitrate Vulnerable Zone, which made things easier from a policy point of view;
- An effective Action Program; and
- Denmark implemented strict regulatory controls on the use of fertilizer and the management of manure.

The results of this Action Plan have been that Danish farms are in compliance and inorganic fertilizer use and nitrate leaching from root zones has declined. This has resulted in a clear trend of declining TN concentrations for streams in cultivated catchments. However, the midterm evaluation of Action Plan III did not indicate that the desired reductions were achieved in the 2003-2008 period, resulting in the decision to lower nitrogen application rate to 15 percent below the economic optimum (Danish EPA, 2012).

A major negative consequence was that some measures severely interfered with agricultural practices and production and the economy of individual farmers. Overall, agricultural production initially declined somewhat (Grant and Blicher-Mathiesen, 2004). But Danish agricultural production has now recovered somewhat from this decline (Simpson, 2013).

The conclusions that can be drawn from the Danish experience (Nimmo Smith, 2007) are:

- Denmark's inorganic fertilizer limits and holistic approach towards fertilization is reducing nitrate loses to the aquatic environment;
- Denmark's strict bureaucratic and regulatory approach is effective;
- Annual accounting system is "inescapable" for farmers;
- Progress was slow, having taken two decades from beginning of implementation. One reason is that environmental response is slow; and
- Success was possible because Danish society as a whole has considerable environmental awareness and there is strong political will for environmental protection.

For the EU in general, "the ability of the Nitrates Directive to protect waters against pollution caused by nitrate from agricultural sources is undermined by a number of vague and ill-prepared guidelines within the directive itself, which may be interpreted differently from state to state" (Nimmo Smith, 2007).

The implementation of the Water Framework Directive (WFD) under the Common Implementation Strategy (CIS) provides an opportunity to refine water policy to address the inadequacies of the Nitrates Directive (ND). The CIS was established by the European Commission in 2001. Its purpose is to develop a common approach for implementation of the WFD throughout the EU, develop technical guidance for Member States, and in general, limit the risk of poor implementation of the Directive (Overview of the Common Implementation Strategy). The EC produces an updated 'Work Programme' for CIS every two years. The Work Program "outlines progress with implementation of the Directive, identifies how the CIS will be organized during that year, lists the key activities for the coming years and provides detailed mandates for how each of the groups will carry out the work." The CIS and its adaptive management approach to implementation provide the means for continuous improvement in the implementation of the WFD and the ND.

United States

The United States has perhaps the most water quality and pollutant data of any country in the world. It also has the most sophisticated watershed and water quality modeling in the world. While this helps provide a sound scientific basis for water quality management decisionmaking, it alone cannot ensure the achievement of water quality goals. While the U.S. has many programs to control water pollution, both point and nonpoint sources, and has had some measure of success, significant barriers remain to restoring or maintaining water quality of surface waters. And while comprehensive basin restoration efforts, such as the one for Chesapeake Bay, seem to have most of the necessary elements for success, implementation usually looks better on paper than it is in reality.

Efforts to restore the Chesapeake Bay, one of the most ecologically valuable estuaries in the world, stretch back nearly 40 years. Despite extensive efforts involving the federal government and six states, efforts that have resulted in significant reductions in nutrient loadings, the timeframe for achieving water quality goals extends at least another 15 years. In addition, significant barriers to success remain, many of them similar to those that are hampering successful implementation of the Nitrate Directive in the EU. Among them are:

- The Clean Water Act, the statutory basis for regulating water quality, provides no federal authority over nonpoint sources, nor does it provide any means to address atmospheric deposition of pollutants, including nitrogen, that adversely affect water bodies;
- Inadequate scientific understanding of the link between agricultural activities and the water quality of surface waters. As good as the U.S. monitoring and modeling currently is, a great deal of uncertainty still remains, especially in characterizing pollutant loads and predicting water quality responses to load reductions;
- Long lag times between reducing on-farm nutrient losses and water quality responses estimated to be 30 years or more in some Chesapeake Bay watersheds (due mostly to slow movement of polluted groundwater;
- Extremely high costs, especially for controlling nutrient discharges associated with urban stormwater;
- The economic slow-down;
- Lack of belief by farmers that they are causing water quality problems;
- Uncertainty about what is actually occurring on farms (similar to what has been described as the English "farmer truthfulness" issue;
- The political influence of farmers;
- Significant political opposition to almost any environmental regulatory requirement that would adversely affect economic activity;
- Political unwillingness to regulate agricultural activities; and
- Ineffective state and federal conservation subsidy programs.

Efforts to reduce nutrient loadings to the Gulf of Mexico and reduce the frequency and extent of hypoxia in the "dead zone" are years behind the Chesapeake Bay effort. Establishing a pollution budget for the Gulf (a TMDL) and initiating a large-scale restoration program like that for the Chesapeake is decades in the future.

In essence, while the U.S. can claim much progress in advancing the science, developing state-of-the-art monitoring regimes and modeling tools, implementing comprehensive programs for restoring and protecting surface waters, it cannot yet claim a large degree of successes.

3.2 Summary and Conclusions

A wide variety of approaches to controlling agricultural nonpoint source pollution are found around the world. However, no country has been fully successful in reducing agricultural loads to the levels necessary for restoring and maintaining water quality. A variety of management frameworks have been developed along with a range of policy instruments to be tried. Because of the difficult nature of diffuse pollution and the unique characteristics of agriculture, there are no easy answers or quick solutions. Globally, achieving fully sustainable agriculture is a work in progress.

The policy instruments described in this section provide a range of options to select from. There is little doubt, however, that to be successful, a water quality management program must implement a mix of policy instruments, as well as a mix of regulatory requirements and voluntary programs. Every watershed is different, as are the regions and countries of the world. Each program must be customized for the culture, country, or region in which it is located and appropriate policy instruments implemented. Water quality management planning should also take an adaptive management approach. As different approaches are experimented with and more is learned, strategies should be adjusted to take advantage of new knowledge. Water quality management will be a continuous learning experience for many years to come.

This section also described the necessary technical elements of a water quality management program. They are scientifically-defensible water quality and pollutant loading monitoring programs, and rigorous analytical frameworks and reliable predictive water quality and loading models. Without these elements, water quality management actions would be nothing more than guesses.

4. RECOMMENDATIONS FOR THE MANILA BAY MANAGEMENT STRATEGY

4.1. Introduction

This section presents WRI's preliminary recommendations for strategies and tools for use in the restoration of Manila Bay. They should be considered preliminary in that they are not derived from an in-depth review by WRI of the environmental, technical, social, political and legal issues surrounding the efforts to restore Manila Bay. Such an evaluation was not within the scope of WRI's assignment from PEMSEA. However, the history and issues were reviewed to a degree that enables WRI to identify strategies used internationally and lessons learned from those experiences that may be useful to the Manila Bay project.

WRI's recommendations are broken down into four general categories: management approach, technical approach, specific tools, and some additional observations that may be useful.

4.2. Management Approach

A comprehensive management strategy is needed for Manila Bay. This approach is clearly embodied in the Manila Bay Coastal Strategy, the Operational Plan for the Manila Bay Coastal Strategy, and the Supreme Court mandamus. All three recognize that the forces and factors harming the Bay constitute a Gordian Knot of environmental, social, and economic issues that must all be addressed simultaneously if the effort is to be successful. Accordingly, the Coastal Strategy, Operational Plan and mandamus collectively address all causes of degradation and sources of pollution, ranging from untreated sewage to poor solid waste management to overfishing, and identify actions that must be undertaken to address them, as well as assigning responsibilities and setting timetables.

The Department of Environment and Natural Resources (DENR) is the primary agency responsible for the "conservation, management, development, and proper use of the country's environment and natural resources" and for the implementation and enforcement of the Operational Plan for the Manila Bay Coastal Strategy.

The mandamus directed the DENR to "fully implement its Operational Plan for the Manila Bay Coastal Strategy for the rehabilitation, restoration, and conservation of the Manila Bay at the earliest possible time" and to "call regular coordination meetings with concerned government departments and agencies to ensure the successful implementation of the aforesaid plan of action in accordance with its indicated completion schedules" (Supreme Court of the Philippines, 2008). The Supreme Court also established an advisory committee comprised of two members of the Court and three technical experts.

In issuing these orders, the Supreme Court clearly recognized the need for a coordinated management approach for the long list of activities required by the mandamus and Operational Plan and for overseeing the large number of agencies with assigned responsibilities. Consideration should be given, however, to going beyond them and establishing an organizational unit whose sole responsibility would be ensuring compliance with the mandamus and the successful implementation of the Operational Plan, i.e., a Manila Bay Management Bureau. The bureau could be led in DENR, and housed there, but with some staffing provided by other key agencies, making it, in reality, an interagency task force. Its responsibilities could include:

- Setting priorities (e.g., needed research, activities, implementation sequence, resource allocations);
- Oversight of efforts in all sectors;
- Program assessment;
- Progress reporting;
- Public education;
- Public participation; and
- Communications with elected officials.

An example of such an agency is the Chesapeake Bay Program Office (CBPO) in Annapolis, Maryland established by the U.S. EPA but staffed by employees from federal and state agencies, non-profit organizations and academic institutions. Information about the CBPO can be found at http://www.chesapeakebay.net.

4.3 Technical Approach

In addition to the need for a comprehensive management strategy, the Coastal Strategy, Operational Plan, and mandamus also recognize the need for a holistic watershed approach, one that addresses all of the causes of Manila Bay's degradation. The strategy must:

- Establish a comprehensive water quality and pollutant loading monitoring program;
- Identify all sources of harmful pollution;
- Quantify pollutant loads by source, sector, and location;
- Enable the development, calibration, and verification of watershed and water quality models;
- Assess the impacts of pollutant loads to Manila Bay from all sources and sectors;
- Establish maximum allowable pollution loads to Manila Bay for each important pollutant (pollution budget or watershed cap);
- Develop and evaluate alternatives for reducing pollution loads;
- Allocate allowable pollutant loads to sectors, regions, and sources.

All sources and sectors must be included in this analysis and accounted for under the loading caps. Otherwise, the caps would be meaningless. This does not mean, however, that all sources must be assigned load reductions, they just have to be accounted for in the cap. As an example, runoff from forested lands no doubt contribute nutrient loads to Manila Bay, albeit small ones, and they should be accounted for in the allocations, but it would make little sense to try and require load reductions from forested land.

WRI's fundamental recommendation is that holistic watershed caps should be established and all sources and sectors should be included in the cap and assigned allocations. These sectors and sources include wastewater effluent, untreated sewage, trash and garbage, urban runoff, direct and indirect industrial discharges, agriculture, atmospheric deposition, septic systems, phosphate detergents, marine vessels, and possibly other sources.

The allocation of allowable loads is not simply an ad hoc mathematical exercise, but rather a complex set of policy decisions on how to distribute the cost of restoration to different sources. The role of science in the process is to identify the sources and loads and to determine if different control actions are equivalent, i.e., produce the same water quality response and have the same degree of uncertainty. Following this comes the hard work of integrating all of the technical, social, and economic factors in the setting of the allocations.

WRI, in conjunction with Tsinghua University in Beijing, China, developed and applied an analytical framework called a Pollution Reduction Opportunity Analysis (PROA) that can serve as a decision-support tool in the setting of allocations. The PROA is designed to help identify the most cost-effective solutions for pollution reduction in a holistic manner. The methodology is simple in concept.

1. All sources of the pollutant of concern are identified;
2. Pollutant loadings from each source and/or sector are estimated;
3. Methods of reducing the discharged loads from each source and/or sector are identified;
4. The load reduction potential of each source/sector is identified;
5. The cost of achieving load reductions for each source/sector is estimated on a per mass unit basis (kg per year);
6. The results are graphed in a manner that clearly shows the reduction potential and cost effectiveness for each method and sector.

The PROA tool was first used by WRI and Tsinghua for use by the city of Suzhou, China, in the development of a plan for meeting its assigned target for reduction of ammonia nitrogen discharges to Tai Lake. WRI subsequently developed a PROA to analyze options for reducing total nitrogen discharges to Chao Lake from Lujiang County in the city of Hefei in Anhui Province, China.

The results for Suzhou are shown in **Figure 1** and those for Lujiang County in **Figure 2.**

Figure 1. Ammonia Nitrogen PROA for Suzhou Discharge to Tai Lake, China

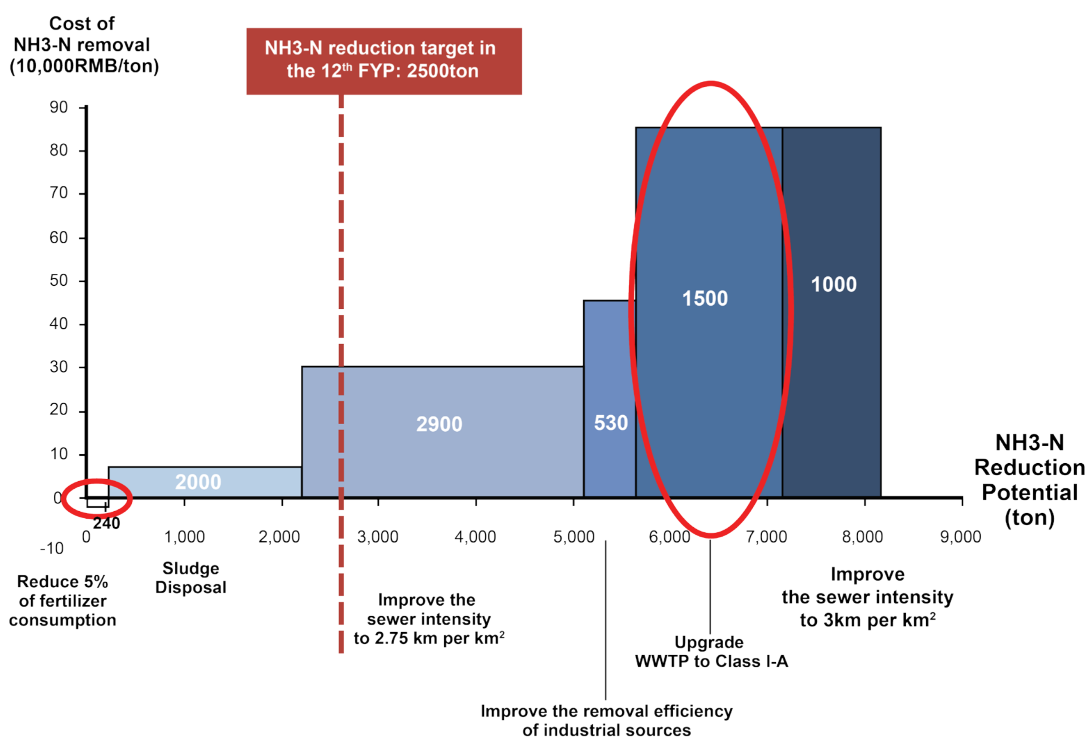
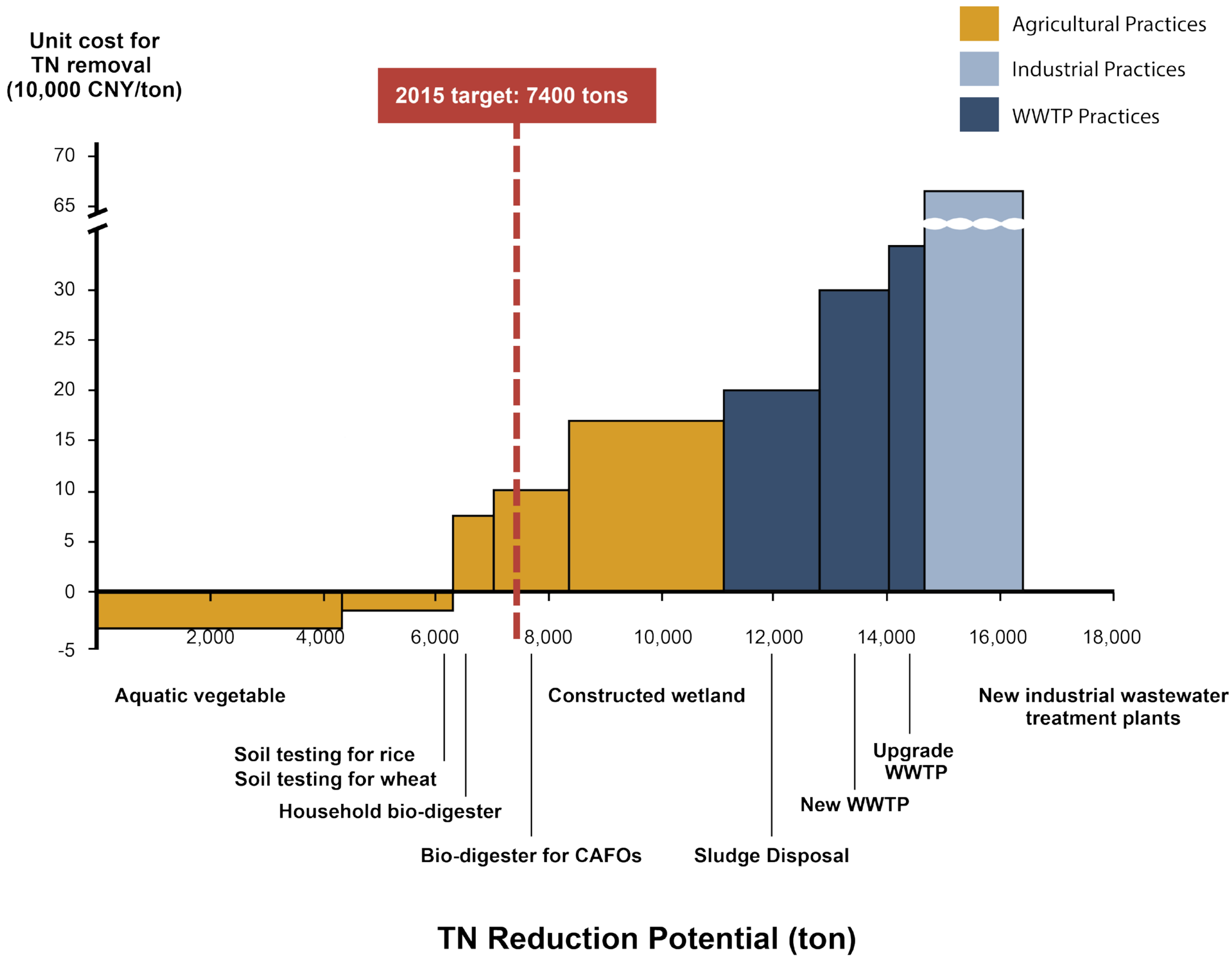


Figure 2.
Total Nitrogen PROA for Lujiang County Discharge to Chao Lake, China



Results are graphed for all available reduction methods, color-coded by sector, and are arranged from lowest to highest cost per ton for the reduction (the vertical axis). Each bar represents a method of reducing the discharged annual load. The horizontal axis units are tons per year and the width of each bar indicates the estimated total reduction potential for that method. Preliminary conclusions about what sources and/or sectors have the greatest potential for reductions as well as cost-effectiveness can quickly and easily be drawn.

Some interesting results from these two PROAs are worth noting:

1. Both graphs show negative costs for some agricultural methods, e.g., reduced fertilizer application rates;

2. In Suzhou, an urbanized area, increased collection of sewage to 2.75 kg per km^2 has the largest reduction potential and moderate unit costs. Upgrading the existing wastewater treatment plants to Class 1-A standards, which is Suzhou's current plan, is far less cost-effective than improving the collection system. In addition, proper sludge management has substantial reduction potential and very low unit costs.

3. Lujiang County is largely agricultural, hence most of the reduction potential is found in that sector. The agricultural reduction methods are by far the most cost-effective ones and substantial negative-cost reductions are available. As in Suzhou, upgrading wastewater treatment plants has far less potential and is less cost-effective.

A PROA graph can be a powerful communication tool. It can present the conclusion of the analysis in a simple and compelling way that is easily understandable by decisionmakers, local governments and other stakeholders. A PROA hopefully would make it easier to reach consensus on a path forward.

4.4 Adaptive Management

The restoration of Manila Bay is a massive undertaking. Many problems, some never before adequately addressed, will have to be dealt with. The institutional, economic, and human resources that will be required are very large and their full deployment will require a great deal of time. There is much to be learned about the causes and cures for Manila Bay's degradation and the development of sufficient scientific understanding is in its early stages.

Some conclusions are obvious however. That letting untreated sewage flow into the Bay is harmful to both the Bay and humans is intuitively obvious and better scientific understanding is not needed in order to make a decision on whether or not to implement control measures. In the long-run however, the devil is in the details — how much control is actually needed, precisely how much control should be done in each sector, and countless other questions that must be answered somewhere along the way.

For these reasons, an adaptive management approach is absolutely necessary. As described in **Section 2.8**, it involves the following steps:

1. Assess the problem;
2. Design solutions;
3. Implement the solutions;
4. Monitor the effects of the solutions;
5. Evaluate the results;
6. Make changes to the solutions to improve the results; and
7. Return to step 1 and repeat the process.

The U.S. National Research Council considered adaptive management nothing less than the incorporation of the scientific method into restoration efforts and provided an articulate and compelling definition:

> *"It is a process of taking actions of limited scope commensurate with available data and information to continuously improve our understanding of a problem and its solutions, while at the same time making progress toward attaining a water quality standard. Plans for future regulatory rules and public spending should be tentative commitments subject to revision as we learn how the system responds to actions taken early on." (NRC, 2001, p.90).*

This is not to suggest that immediate actions should not be taken. There are some areas where actions need not wait for additional research or planning deliberations. Candidates include implementing a phosphate detergent ban, building landfills and implementing good solid waste management, and perhaps improving fertilizer and manure management practices in agricultural areas.

A key principle of adaptive management is that *things don't have to be perfect in order to proceed.*

4.5 Tools to Consider

Phosphate Detergent Ban
Although phosphate detergent bans were initially strongly resisted by detergent manufacturers, today they are widespread in Europe, North and South America, and Asia. The bans drove innovation in by the manufacturers and the industry has largely adapted. Many major international manufactures have or are in the process of completely eliminating phosphates from their detergents. See **Section 2.4** for a detailed summary of this history.

One of the arguments against the bans initially made by the detergent industry is that if phosphate detergents contributed a relatively small percentage of the phosphorus to a water body, then bans would have little or no environmental benefits. While this may be true in some circumstances, the few studies that were done assumed that full sewage collection and treatment was in place. A wastewater treatment plant, even one operating at secondary treatment levels and not designed for phosphorus removal, still removes a significant portion of the phosphorus in the influent. WWTPs that provide tertiary treatment for nutrient removal reduce discharges even more. Hence, under this assumption, a portion of the phosphorus contributed by detergents will be removed by the WWTPs. No scenarios that assumed incomplete wastewater collection and treatment were modeled. A second assumption was that septic system effluent contained little or no phosphorus. This is true for properly maintained septic systems but the reality is that a significant percentage of septic systems are not properly maintained resulting in short-circuiting of flow, discharge of solids containing phosphorus, and surface runoff to water bodies. There are significant discharges of raw sewage to Manila Bay. Hence, a high proportion of the phosphates in detergents used in homes or businesses that are not connected to sewers or properly operating septic systems enters streams, rivers and Manila Bay. Under these circumstances, a phosphate detergent ban could have immediate and significant environmental benefit. The detergent industry as a whole has adapted to phosphate bans and can easily and quickly moved to low or no phosphate detergents in the Philippines, hence, a ban in the Manila Bay watershed could be rapidly implemented and result in an immediate reduction of phosphorus loads to Lake Laguna and Manila Bay.

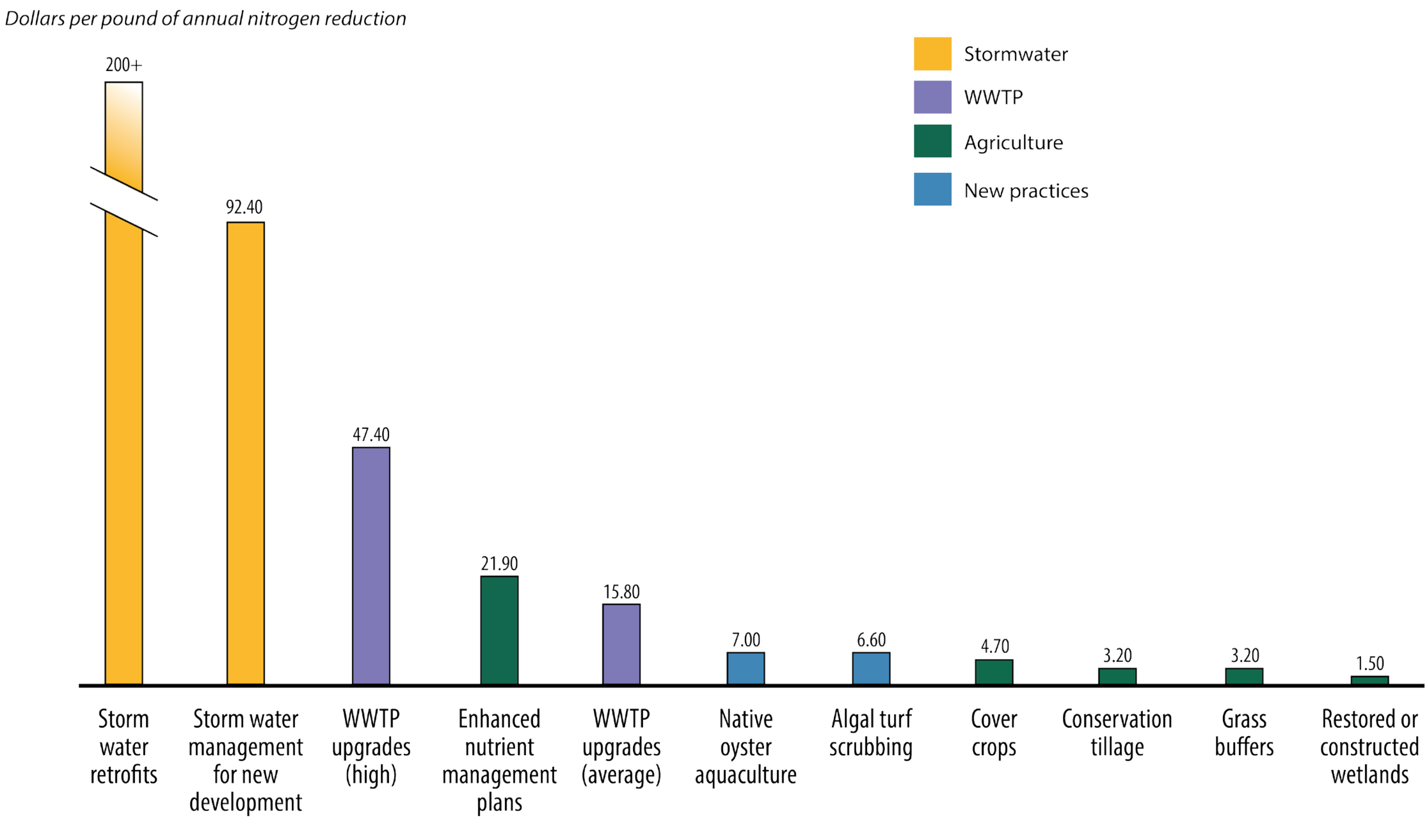
Water Quality Trading

Water quality trading is a market-based approach in which point sources with regulatory requirements to reduce discharges of a given pollutant can buy credits from other sources, either a regulated source or an unregulated one such as a farm. The nonpoint source reductions are frequently less costly to achieve, allowing the point source to meet its regulatory requirements at lower cost than it would have if it upgraded its facilities.

Nutrient trading is worth investigating as a useful tool in Manila Bay restoration efforts. For it to be used successfully, five conditions must be met.

1. Strict watershed caps are set for Total Nitrogen (TN) and Total Phosphorus (TP) and the caps are allocated to sectors and sources.
2. The domestic and industrial wastewater sectors are given regulatory requirements to reduce their discharged TN and TP loads consistent with the cap allocations.
3. Agriculture and/or other unregulated nonpoint sources are a significant source of TN and TP loads to Manila Bay.

Figure 3.
Total Nitrogen Discharge Reduction Costs in the Chesapeake Bay Watershed by Sector.



Source: U.S. EPA and Abt Associates, 2009; Wieland et al., 2009; MDNR, 2008; Stewart, E. A., 2006; WRI analysis using WWTP upgrade costs from MDE and VDEQ.

4. Reductions in loads from agriculture and/or other unregulated nonpoint sources are achievable.
5. Nonpoint source reductions are less costly than point source ones.

Conditions 1 and 2 create a market demand for nutrient credits; without them the wastewater sector would have no incentive to reduce its discharged loads. Conditions 3 and 4 ensure that there would be a potential supply of credits for the market. Condition 5 is necessary to ensure that there would be economic benefits for both potential credit buyers and sellers.

Experience with trading program development has shown that there is almost always a large cost differential between agricultural load reductions and point source ones. **Figure 3** shows one such striking differential — the cost for reducing TN loads to the Chesapeake Bay in the wastewater, stormwater, and agricultural sectors.

The first step in evaluating the potential value of nutrient trading for Manila Bay would be to determine whether the five conditions are currently being met or will be in the near future.

5. ADDITIONAL OBSERVATIONS

Here are two preliminary observations based on WRI's best professional judgment:

5.1 The Role of Wastewater

While the Coastal Strategy, Operational Plan, and mandamus address all causes of Manila Bay's degradation, there seems to be a perception among many that perhaps domestic wastewater is the only important sector and other sectors do not really need to be addressed. This may or may not be true, but actions should not be based on this assumption. The necessary monitoring and modeling must be done to determine if it is true before any plans are finalized.

There is little doubt that improving domestic wastewater collection and treatment is needed. The discharge of untreated sewage should be eliminated as soon as possible to the maximum feasible extent. Further, WRI believes that it is likely that tertiary treatment for nutrient removal will be required at the wastewater treatment plants. This is especially true if wastewater is the predominate cause of Manila Bay eutrophication.

5.2 The Role of Agriculture

There has been little discussion of the potential contribution of agriculture to Manila Bay's eutrophication. This may be due to an assumption that agriculture is not making a significant contribution to the problems. If so, the assumption is premature at best and questionable at worst. Globally, agriculture is the largest source of nutrients to major water bodies suffering from eutrophication and its contribution to Manila Bay must be assessed. Even if wastewater is the dominant cause, it is possible that important gains can be made in the agricultural sector relatively quickly through actions such as better manure management and improved fertilizer practices.

If there is little or no monitoring data on agricultural nutrient runoff for the Bay, monitoring nitrogen and phosphorus fluxes at stream and river outlets to the Bay in order to estimate delivered loads could provide some insight into this question in a relatively short amount of time.

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UNEP

GPA Global Programme of Action for the Protection of the Marine Environment from Land-based Activities

PEMSEA

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