NUTRIENT MANAGEMENT POLICY FRAMEWORK

NUTRIENT ISSUE OVERVIEW

Over the past 50 years, excess nutrients leading to eutrophication and hypoxia has emerged as one of the leading causes of water quality impairment worldwide. Eutrophication, the over-enrichment of water bodies with nitrogen and phosphorus, can lead to algal blooms that block sunlight and consume oxygen when they decompose, thereby leading to hypoxic conditions. Hypoxic areas, or "dead zones," can lead to fish kills and even the collapsing of ecosystems.

Although nutrients are naturally found in the environment and are critical for food production, the Millennium Ecosystem Assessment found that human activities have doubled nitrogen and tripled phosphorus levels over natural conditions (2005). These excess nutrients are largely a result of more intensive agricultural activities and increased wastewater due to a growing global population. The water quality problems associated with excess nutrients are expected to escalate as the planet prepares to accommodate 9 billion people by 2050 (Sutton et al. 2013).

There are more than 500 million small holder farmers in the developing world who will have to better balance increased food production with sustainably managing nutrients (Lowder et al. 2014). More wastewater will need to be collected and treated, particularly in developing countries where fewer than 35 percent of cities have any kind of sewage treatment (UNEP and WHRC 2007). New integrated approaches to manage nutrients across various disciplines (i.e., agriculture, aquaculture, livestock and wastewater) are needed to ensure environmental, economic, and social benefits for key stakeholders and coastal ecosystems.

BACKGROUND ON FRAMEWORK

The Global Partnership on Nutrient Management (GPNM) is a platform for governments, the United Nations, scientists, and the private sector to work together to minimize the negative impacts of nutrients on the environment and human health while maximizing food security, poverty reduction, and sustainable development. The GPNM members are implementing a Global Environment Facility and United Nations Environment Programme project entitled "Global foundations for reducing nutrient enrichment and oxygen depletion from land-based pollution, in support of Global Nutrient Cycle" (GEF GNC). As part of this GEF-GNC project, GPNM is developing a nutrient management framework to inform nutrient management policies and present opportunities for scaling up the implementation of key best practices.

This nutrient management framework serves as a resource for policy makers, particularly at the country level in the developing world, to design effective policies and programs for managing nutrients. The general framework was adapted from *Toward a Comprehensive Watershed Management Strategy for Manila Bay: The International Experience and Lessons Learned* (World Resources Institute and PEMSEA, 2015). In addition, specific priority best practices and policies will be highlighted based on experiences in two developing country focus areas: Manila Bay, Philippines and Chilika Lake, India (see Box 1).

Box 1. Focus Areas

Chilika Lake, India

Chilika Lake is a coastal lagoon located along the Orissa coastline in eastern India. It is one of Asia's largest brackish bodies of water, serving as an important habitat for migratory birds and endangered species. More than 200,000 people depend on the lake's fishery resources for their livelihood. The catchment is predominantly agricultural land, particularly rice, leaving Chilika Lake vulnerable to nutrient and sediment loads as the region increases productivity in the face of population growth.

Manila Bay, Philippines

Manila Bay is a natural harbor located around Manila, the capital city of the Philippines. It is an important commercial resource for the region's socio-economic development. Its mangroves and wetlands also provide important habitat for aquatic life, birds, and wildlife. Industrialization and population growth in the catchment have negatively affected the Bay. Untreated sewage is a major contributor to the poor water quality.

Additional resources developed under the GEF-GNC project may also be of value to policy makers, such as a global nutrient management toolbox which includes searchable databases of more than 200 best practices and policies, case studies, and a river basin scale nutrient loading calculator. More information on GPNM and the toolbox can be found at nutrientchallenge.org.

COMPONENTS OF A NUTRIENT MANAGEMENT POLICY

This section provides an introduction to each of the key components, including options for various mechanisms within each component, of an effective nutrient management policy and shares specific examples of promising strategies based on experiences in the two developing country focus areas.

A 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 and implementing integrated solutions. Without them, any water quality management strategy would be piecemeal and guesswork. The tools and analytical frameworks that are needed for evaluation and decision-support are as follows.

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 objectives of the monitoring are to 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, untreated sewage, direct and indirect industrial discharges, septic tanks, atmospheric deposition, and release of pollutants from bottom sediments of the water body.

EXAMPLE: WATER QUALITY MONITORING AND MODELING FOR CHILIKA LAKE

The Chilika Development Authority, which oversees the lake's restoration, has a robust water quality monitoring system, tracking salinity and water clarity, among other water quality indicators. A water quality monitoring framework is an important first step for regions with limited to no understanding of water quality conditions.

Although the Chilika Development Authority uses sophisticated autonomous buoys that provide data telemetrically in real time, regions that are just getting started can still benefit from using less sophisticated instruments such as secchi disks, which measure water clarity, and could be used by citizen groups, not just scientists.

The next step for Chilika Lake, and other regions with monitoring systems in place, is to increase understanding of how the monitored data is influenced by changes in the catchment. The Chilika Development Authority would benefit from investing future resources in identifying sources of pollutants and developing a watershed model to study how changes in pollutant loads may affect water quality in the lake.

PREDICTIVE MODELS

Modeling for watershed-based water quality management has two objectives: to predict the pollution inputs to the water body from point and nonpoint sources, and to predict the response of the water body to those inputs. The model used for the first objective is referred to as a watershed model. Using existing and projected future pollutant loads, it simulates pollutant fate and transport mechanisms on the land surfaces and in rivers and streams tributary to the water body. A water quality model then simulates the impacts of these pollutant loads on the water body. Together, these models are used to predict the impacts of different management scenarios and to determine maximum loading rates that are possible without compromising water quality.

Under the GEF-GNC project, partners are undergoing a global modeling analysis to predict nutrient sources and loads and assess the effects of those loads on coastal ecosystems. Once completed, decision makers will be better equipped with tools to help guide cost-effective nutrient reduction planning in their watersheds.

DETERMINATION AND ALLOCATION OF ALLOWABLE POLLUTION LOADS

Once the predictive models have established the maximum allowable pollutant loads to a water body, pollution control scenarios can be developed and evaluated using a number of criteria including environmental, economic, and social impacts. This process culminates with the 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.

In order to allocate loads, 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, untreated sewage, direct and indirect industrial discharges, septic tanks, atmospheric deposition, and release of pollutants from bottom sediments of the water body.

EXAMPLE: COMPREHENSIVE STRATEGY FOR THE RESTORATION OF MANILA BAY

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) with the Department of Environment and Natural Resources (DENR) as the lead government agency for the project. With collaboration and input from a wide variety of stakeholders, including national, regional, and local government agencies; academe; civil society; the private sector; and religious organizations, the Program Management Office of the MBEMP released the Manila Bay Coastal Strategy in 2001.

The Coastal Strategy set five major goals, each supported by specific objectives and action programs. The major goals are to (1) protect human welfare and the ecological, historical, cultural and economic features of Manila Bay; (2) mitigate environmental risks that occur as a consequence of human activities; (3) strike a balance between economic development and environmental management; (4) ensure the involvement and active participation of stakeholders in the development and implementation of environmental management programs; and (5) direct the formulation and implementation of policies and institutional mechanisms to achieve sustainable development in Manila Bay.

The MBEMP followed up the Coastal Strategy with the release of the Operational Plan for the Manila Bay Coastal Strategy (OPMBCS) in 2005 (Manila Bay Environmental Management Project, 2005). Successfully implementing the Operational Plan will require a science-based holistic approach. Accordingly, the MBEMP and key stakeholders are in the process of developing the tools and analytical frameworks that will be needed for successful implementation. The tools and analytical frameworks that are needed are (1) water quality monitoring programs, (2) pollutant source identification and loading measurement, (3) assessment methodologies, (4) predictive water quality and loading models, and (5) decision-support tools and load allocation methodologies.

LEGISLATIVE AND REGULATORY COMPONENTS

Effective water quality management is not possible without some degree of legislative and regulatory requirements. Important requirements fall into two general categories: first, mandatory environmental standards and assigned legal responsibilities for pollution discharge reductions and water quality management activities; and second, enforcement of these requirements.

I. ENVIRONMENTAL STANDARDS

There are four types of environmental standards that are critical for attaining water quality goals:

- Water quality standards—These standards are generally expressed as water uses to be protected, and numeric criteria that ensure that the uses are possible;
- Watershed pollution loading caps and enforceable discharge allocations to sources;
- Discharge limits for point sources; and
- Practice-based standards for agriculture and aquaculture.

EXAMPLE: PHOSPHATE DETERGENT BAN FOR MANILA BAY

Phosphate detergent bans have become common in developed countries over the last forty years. The bans were designed to help prevent eutrophication of lakes and coastal areas. The detergent industry initially resisted the bans but responded to them with new innovations in soap and detergent formulation. Since the onset of the bans, which are now globally wide-spread, detergent manufacturers have found effective substitutes for phosphates.

Phosphate detergent bans are particularly effective in urban areas where signicant amounts of sewage are not collected and treated, but instead directly enter ditches, streams, rivers, lakes, or coastal areas. Bans in these areas would result in an immediate and significant reduction in phosphorus loadings to economically and ecologically important water bodies. Such is the case for the Manila metropolitan area in the Philipinnes. A recent report published by the Partnership for the Environmental Management of the Seas of East Asia recommended strong consideration of a phosphate detergent ban in the Manila area (WRI and PEMSEA 2015).

COMPLIANCE AND ENFORCEMENT MECHANISMS

Mechanisms must be in place to ensure that regulatory requirements are 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 effective enforcement mechanism that can be used when noncompliances are found.

VOLUNTARY PROGRAMS FOR AGRICULTURE

It is not likely that widespread regulations that require farmers to change practices and behaviors that cause water pollution will be implemented in most countries. Hence, ways must be found to encourage farmers to do so on a voluntary basis. In developing regions where agricultural operations are generally on a small scale, there are four basic attributes of appropriate conservation practices: adaptability to small and limited resource farms, affordability, applicability to local conditions, and acceptability culturally and socially. These 4As are critical for program managers to consider, particularly for small holding and limited resource farms.

Three types of voluntary programs aimed at reducing agriculture nonpoint pollution are in use in the United States and Europe and could be adopted in other regions through the lens of the 4As.

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 management practices (BMPs), which farmers can use on a voluntary basis.

EXAMPLE: CONSERVATION PRACTICE STANDARDS

The United States Department of Agriculture's National Resources Conservation Service maintains a handbook of agricultural conservation practices. The standards provide landowners and technical service providers with information on what kinds of voluntary practices can be implemented to address particular resource concerns; where they can be implemented; and how they should be designed, implemented, and maintained (USDA NRCS, 2016).

While types of practices may vary geographically, many are applicable for various regions and various types of agriculture. In addition, the framework for this handbook and its content can be replicated and adapted for other areas. To be most useful, it's important that any investments in creating conservation practice standards are paired with investments in technical and financial assistance for education on and implementation of the practices.

EDUCATION AND OUTREACH TO FARMERS

Farmers are sometimes unaware of the environmental impacts of their farming practices, particularly if those impacts occur in distant water bodies. 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 change. Elements of an education program could include providing information on the following:

- The connection between the land and the water quality and ecological health of streams, rivers, and lakes, as well as the ecosystem services that the water bodies provide to people, such as safe drinking water supply and productive fisheries;
- Identification of phosphorus, nitrogen, COD and sediment as the important pollutants;
- The connection between farming practices and pollution loads;
- The actions farmers can take 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 make changes.

TECHNICAL ASSISTANCE PROGRAMS

Technical assistance programs for farmers are critically important. Key areas of technical assistance include:

- Providing farmers with conservation technology and the means to keep their lands healthy and productive by reducing soil loss from erosion, and solving soil, water quality, water conservation, air quality, and agricultural waste management problems;
- Enhancing the quality of fish and wildlife habitat;
- Improving the long term sustainability of all lands, including cropland, forestland, grazing lands, coastal lands, and developed and/or developing lands; and
- Facilitating the practical application of agricultural research and providing instruction and demonstrations for farmers on improved practices and technologies.

The GPNM partners—Global Environment and Technology Foundation, World Resources Institute, and Energy Research Centre of the Netherlands—have developed a valuable resource for agricultural technical assistance providers. Technical assistance providers can search a database of about 100 best management practices using various conditions such as climatic zone and suitability for small farms. The searchable database is available at nutrientchallenge.org/toolbox/gpnm-toolbox.

EXAMPLE: TECHNICAL ASSISTANCE FOR CHILIKA LAKE

The catchment of Chilika Lake has an active technical assistance program. Traditional assistance has focused on increasing yields with the use of chemical fertilizers. However, the farmers and the extension agents in Chilika Lake are noticing declining yields and soil compaction. To date, there has not been sufficient attention given to nutrient management as an agricultural best management practice.

Education and training on the 4 Rs of nutrient management—right source, right time, right place, right rate—is not only necessary for managing nutrients to Chilika Lake but of interest to many of the farmers who stand to benefit from improved soil quality, increased yields, and cost savings. Providing greater technical assistance around nutrient management and other agricultural best management practices in developing countries is an excellent way to cost-effectively manage nutrients while also supporting rural livelihoods.

ECONOMIC POLICY INSTRUMENTS FOR NONPOINT SOURCE POLLUTION CONTROL

There are four general economic policy instruments for controlling agricultural nonpoint source pollution. The following economic instruments provide financial incentives to farmers to practice good management and are valuable additions to a comprehensive nutrient management policy. Economic instruments can complement voluntary programs, providing sometimes necessary incentives for additional voluntary practice adoption.

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.

SUBSIDIES FOR CONSERVATION PRACTICES AND ENVIRONMENTAL PROTECTION

These subsidies include 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; and to help farmers meet environmental requirements. Other programs provide financial incentives for the retirement of erodible or sensitive environmental lands.

PAYMENTS FOR ECOSYSTEM SERVICES

Payments for ecosystem service (PES) programs involve paying landowners to preserve or restore ecosystems on their lands that provide ecosystem services. Programs for water-related services 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. Most active PES programs around the world are for the purpose of protecting watersheds and forests or both.

With specific nutrient reduction goals in mind, PES programs can be structured to pay for performance. Pay-for-performance approaches provide financial incentives according to the environmental outcomes achieved. Therefore, these programs give landowners the flexibility to implement practices of their choosing, likely those with greatest cost effectiveness, ensuring viability for the farm operation and reductions in nutrient loads (Winsten, 2009).

WATER QUALITY TRADING PROGRAMS

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 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. Trading can also sometimes provide ancillary environmental benefits such as increased wildlife habitat.

EXAMPLE: WATER QUALITY TRADING FOR MANILA BAY

Water quality trading programs work well when there are a diversity of pollutant sources, particularly point sources, with regulatory discharge requirements. Wastewater is considered to be an important sector that needs to be addressed to improve water quality in Manila Bay. Some level of wastewater treatment is needed, and it is likely that at least tertiary treatment will be required in the future. If and when there are caps on nutrient loads, with allocations to all sectors, a water quality trading program may be a cost-effective way for regulated sources to meet their cap. For trading to be successful in Manila Bay and other regions, there must be opportunities to reduce loads from nonpoint sources or other point sources, with cost differentials among the sectors.

PUBLIC EDUCATION AND PARTICIPATION

Educating the public about the ecological degradation of water bodies and the loss of ecosystem services, and providing the public with 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 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, industry, and academe can all provide valuable information and input to the decision-making process;
- Better public understanding of the problem, alternative solutions, and decision-making 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.

EXAMPLE: ECOSYSTEM NUTRIENT HEALTH REPORT CARD

Report cards for ecosystems are transforming how science is communicated to the public. The University of Maryland Center for Environmental Science has pioneered ecosystem health report cards all around the globe, including for the Great Barrier Reef and Chilika Lake. Using indicators such as water quality, fisheries status, and biodiversity, annual assessments of ecosystem health are graphically communicated in a reader-friendly manner (UMCES IAN, 2016).

FLEXIBILITY AND ADAPTATION

Water-quality management is accompanied every step of the way by uncertainty. Water quality and watershed models are imperfect tools and are never free of some 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 a flexible adaptive management approach, one which 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.

An important implication of this approach is that care should be taken in mandating far-reaching or expensive requirements in the face of excessive uncertainty. Another is a recognition that things don’t have to be perfect in order to proceed. The key is to work continuously to improve scientific understanding as steady progress is made toward water-quality goals.

CONCLUSION

The policy instruments described in this document are meant to provide a workable framework for a country or region looking to develop a nutrient management policy. Through monitoring and modeling pollutants and sources, regulating nutrients, providing voluntary programs and/or economic incentives, while engaging and educating the public and adaptively managing, a holistic strategy for nutrient management is possible. As decision makers develop policies around managing nutrients, it is important to note that every policy should be customized to the economic, social, cultural, technical, and political realities of the country or region. And through adaptive management, strategies can be adjusted over time.

For more information on effective nutrient management policies and practices, please visit nutrientchallenge.org.

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