The Conservation and Management of Our Freshwater Ecosystems

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ABSTRACT

The Philippines has various freshwater ecosystems consisting of lakes, swamps, rivers, reservoirs and ponds with an aggregate area of more than 370,000 hectares. These resources are valuable to the economy and to biodiversity.

Reservoirs provide over 40% of the country's power requirements in the form of hydroelectricity, which supplies water for irrigation, industries and domestic needs. There are 43 known indigenous freshwater fishes in the country in addition to numerous aquatic invertebrates and plants present in our lakes, swamps and rivers.

The major problems affecting the conservation of our freshwater ecosystems are pollution, siltation and overfishing. Enforcement of the existing anti-pollution and fishing laws and regulations is weak in regions outside Metro Manila. Heavy erosion of watershed areas and unabated release of mine tailings and other wastes into rivers have contributed much to their deterioration in many areas of the country, particularly in Luzon. Use of illegal fishing gear has resulted in the depletion of many endemic fishes. Accidental stocking and indiscriminate introduction of exotic species have also threatened the existence of our endemic species.

Following is an eight-point agenda for action on conservation of our freshwater ecosystems.

INTRODUCTION

Water is essential for life. The development of civilization has been dependent on the availability of freshwater for domestic and industrial uses. Although over 70% of the world's surface is covered with water, only less than 1% is available as freshwater for human life. The conservation of our freshwater resources is thus vital for our survival.

The Philippines has various freshwater ecosystems consisting of lakes, swamps, reservoirs, rivers, ponds and small impoundments with an aggregate area of over 370,000 ha (Table 1).

Our freshwater ecosystems are valuable resources from the standpoint of the economy, as well as that of biodiversity. Lakes, swamps and rivers are sources of fisheries products and livelihood to thousands of fisherfolk. Reservoirs provide more than 40% of the power requirement of the country through hydroelectric plants, which supply irrigation to about 1.5 million ha of agricultural land. The domestic water supply of Metro Manila mainly comes from dams. The freshwater fisheries from our inland waters contributed 222,257 metric tons or 11% of the total fisheries production of the country in 1989 (BFAR 1990). There are 43 indigenous freshwater fishes recorded in the Philippine taxa (De la Paz 1988) in addition to numerous aquatic invertebrates and plants.

This paper discusses the status and management of the freshwater ecosystems in the Philippines. An agenda for action on the conservation of these resources is also presented for consideration by policymakers and implementing agencies.

STATUS AND MANAGEMENT OF OUR FRESHWATER ECOSYSTEMS

A. Lakes

Lakes are natural water impoundments formed by processes like volcanic or seismic activity. There are six major and 52 minor lakes in the country with an aggragate area of 200,000 ha (PCARRD 1981). Our six major lakes are Laguna de Bay (90,000 ha), Lake Lanao (34,000 ha), Lake Taal (33,432 ha), Lake Naujan

(8,000 ha), Lake Mainit (7,340 ha) and Lake Buluan (6,500 ha). Except for Laguna de Bay, there is a paucity of information available on the status of lakes in the Philippines. Only Laguna de Bay and Lakes Lanao, Taal, Naujan and Buhi are discussed here.

Laguna de Bay is a eutrophic lake with an average depth of 2.5 m. It has multiple uses, which are for fisheries, irrigation, power generation and industry (Davies 1988). There are eight endemic fish species in the lake in addition to six migratory species and six other introduced ones. Only one endemic species, the kanduli (*Arius manilensis*), has been extensively studied.

There are about 10,000 fishermen dependent on the lake for their livelihood. The fish catch consists of the **ayungin** (*Therapon plumbeus*) and the **puting bia** (*Glossogobius giurus*), which represent about 93 percent of the open-water fish harvests. Low-value snails and shrimps utilized largely for duck feed constitute the bulk of the capture fisheries of the lake. The total fisheries catch of the lake decreased by 75% from 82,882 mt in 1961-63 to 20,723 mt in 1979 because of overfishing with the use of efficient fishing gear like the motorized push net (Mercene 1990).

The fishpen culture of milkfish was introduced in the lake in the early '70s to utilize its primary production and lessen fishing intensity by encouraging fishermen to engage in fishfarming (Delmendo 1987). In the middle '80s the fishpen hectarage in the lake had reached 35,000 ha, far exceeding the 20,000 ha authorized by the Laguna Lake Development Authority (LLDA) which set a fishpen belt zone to regulate the industry. While increasing the fisheries production of the lake through aquaculture, the fishpens reduced the fishing area for fishermen and brought about not only a decrease in their fish catch but also social conflict. To protect the open-water fisheries, a 5,000-ha fish sanctuary was established in the lake by the LLDA.

Domestic sewage and agricultural run-off made Laguna de Bay highly eutrophic and vulnerable to fishkills in the '60s and the '70s. Soil erosion from the watershed of the lake has resulted in its rapid sedimentation. To prevent the backflow of the polluted waters of the Pasig River into the lake during the months of April to July and to protect Metro Manila from floods in the rainy season, a hydraulic control structure was constructed in the Napindan Channel in 1983.

Pollution and siltation are the two major problems adversely affecting the water quality and fisheries of Laguna de Bay at present. There are more than 1,100 industrial and agricultural establishments operating in the lake basin that contribute to its pollution (Cuvin-Aralan 1989). Heavy siltation of the lake has resulted in high turbidity of its waters, which limits primarily productivity and consequently production (Santiago 1991).

Lake Lanao is an oligotrophic lake with an average depth of 60.3 m. It has been declared a national park and reserve, and is under the jurisdiction of the Bureau of Forest Development. The lake and Agus River are the sources of hydroelectricity supplying 70% of Mindanao's power requirements.

The lake is important in terms of biodiversity because of its 20 endemic species of cyprinid fishes (IUCN 1990). Accidental introduction of the white goby (*G. giurus*) has threatened the cyprinid population of the lake (Juliano et al. 1989). No fisheries conservation program for the lake is being done.

Lake Taal is an oligotrophic lake with a maximum depth of 200 m. The lake is famous for its volcano island, which is a national park, and its **tawilis** (*Harengula tawilis*) fishery. The tawilis is one of the few freshwater clupeid fishes in the world. The fishery provides livelihood to 80 percent of the fishermen of the lake. In 1989, the total landed catch was 10,650 mt or 4.7% of the total catch from the country's inland waters (Castillo undated).

The tawilis was at one time threatened with overfishing by ring- net fishermen using lights to attract the shoaling fish. As a conservation measure, the Department of Agriculture, through the Bureau of Fisheries and Aquatic Resources, promulgated Fisheries Administrative Order 82 banning the use of strong lights and limiting the operation of ring nets only from mid-August to mid- October. Fishing for the species is also prohibited during its spawning season from November to January. A fish sanctuary to protect the tawilis has also been established in the lake (Zafaralla 1989).

Lake Naujan was declared a national park in 1956. It has a rich fish fauna, which supports the fisheries of demersal and pelagic species. Fishing in the lake is intensive and there is conflict between conservation of the resource and commercial fishing activities. Among the fishing regulations imposed are the

issuance of fishing permits, prohibition of fishing between 4 a.m. and 5 p.m. and the maintenance of a fish sanctuary. Enforcement of the regulations, however, is poor (IUCN 1990).

Lake Buhi, although a minor lake in terms of area (1,707 ha), is significant for having the **sinarapan** (*Mistichtys luzonensis*), considered the world's smallest commercially important fish. The population of the species has been declining since 1979 as a result of overfishing, introduction of exotic species and siltation (Depthnews 1990).

The operation of motorized push nets, which destroys the shelters of the sinarapan, has been banned by the Bureau of Fisheries and Aquatic Resources (BFAR). Introduction into the lake of the Mozambique tilapia in the '50s and the freshwater shrimp (*Macrobrachium* sp.) in the '70s is believed to have contributed to the depletion of the fishery (Gindelberger 1981). The BFAR has taken steps toward the protection of the species by prohibiting sinarapan fishing in nearby lakelets where it still abounds.

B. Swamps

Swamps or marshes are water-logged areas with grassy vegetation. The major freshwater swamps of the Philippines are the Liguasan Marsh (220,000 ha) and the Agusan Marsh (89,359 ha) in Mindanao and the Candaba Swamp (32,000 ha) in Central Luzon (IUCN 1990).

Liguasan Marsh forms the basin of the Mindanao River in North and South Cotabato and consists of a vast complex of river channels, small freshwater lakes and ponds. A portion of the marsh (30,000 ha) was declared a Game Refuge and Bird Sanctuary in 1979. There are about 20 species of fishes described in the swamp. Access to the area is limited because it is the stronghold of the MNLF. This freshwater ecosystem is probably the best protected in the country today.

Agusan Marsh consists of freshwater marshes and water courses with numerous small shallow lakes and ponds in the upper basin of the Agusan river and its tributaries. The area has been declared a reserve and crocodile sanctuary.

Candaba Swamp is a complex of freshwater ponds and grasslands on a vast floodplain. The area is flooded in the wet

season but it becomes arable in the dry season. Among the conservation measures proposed are the establishment of a wildlife sanctuary and a reservoir for fisheries and irrigation.

The other swamps of importance in the country are the Leyte Sab-a Basin (90,000 ha) and the Buguey Wetlands (14,400 ha) in Cagayan. Little is known about the fisheries of these swamps.

C. Reservoirs

Reservoirs are man-made impoundments constructed primarily for irrigation and power generation. They are also important for fisheries because of the endemic species in the rivers that supply them, fish introductions and aquaculture. There are more than 1,000 impounding dams and reservoirs in the country with a dam height of over 3 m (PCARRD 1981). The common fishes caught in our reservoirs are tilapias, the common carp and the white goby. The management of only two of our largest reservoirs is discussed in this section.

Pantabangan Reservoir in Nueva Ecija, built in 1974, is the largest in the country with an area of 8,900 ha. It is managed by the National Irrigation Administration (NIA). Introductions of tilapias, carps and milkfish into the reservoir by the BFAR have contributed to a limited extent to the livelihood of the fishing community in its watershed. Heavy erosion of the watershed has resulted in the reservoir's rapid sedimentation and relatively low fisheries productivity. Fishing rules and regulations have been formulated by the NIA but these are poorly enforced (Johnson 1975).

Magat Reservoir in Ramon,Isabela is the second largest in the country with an area of 4,460 ha and a maximum depth of 80.5 m. The reservoir sits at the foothills of the Cordillera Mountain Range. It became operational for generating hydroelectricity, as well as irrigation and fisheries purposes in 1982.

The total fish landings in 1987 and 1988 by about 700 fishermen using gill nets, hooks and lines, traps and case nets were 1,785 mt and 1,713 mt, respectively. Nile tilapia (*Oreochromis niloticus*) comprised 31.8% of the total catch, followed by the ayungin (*Therapon plumbeus*), catfish (*Arius magatensis*), carps, goby, mudfish, eel and shrimps. In addition to the open-water fisheries, Nile tilapia is also extensively cultured in floating

fish cages in the reservoir. There were 785 cage units with a total area of 56.3 ha operated by 212 fishfarmers in 1986 (De los Trinos personal communication). NIA strictly enforces fishing regulations.

The fisheries of the other major reservoirs, such as those of Ambuklao, Binga, Angat and Caliraya, have not been studied well. These reservoirs are being managed by the National Power Corporation. Late report has it that the Ambuklao and Binga Reservoirs in Benguet are heavily silted due to serious watershed erosion and are no longer suitable for fish production (Angulan personal communication).

D. Rivers

There are 421 major rivers in the Philippines, with drainage areas or basins ranging from 40 - 25,000 sq km. With an annual precipitation of 2,269 mm, the country has an estimated average annual run-off of about 256,980 million cubic meters (EMB 1990). Because of their proximity and accessibility to urban and industrial centers, our river systems are the most vulnerable to pollution among our freshwater ecosystems.

A recent item in a national newspaper had the lead: "Four of 17 Luzon Rivers Found 'Dead'." The biologically dead rivers identified were the Maasin-Potiero-Gumain River System, Caulamang-Marella River System, Pamatawan River and Rio Chico in Bulacan and Pampanga. The San Fernando River in Pampanga was also reported to be the most heavily polluted (Arias 1991). In another news item, it was revealed that only 12% of the Metro Manila population had access to sewers and that while 40% of all rivers in the country are now "dead", all the rivers in Metro Manila are "dead" (Giron 1991).

Four major rivers in the Ilocos Region -- the Abra, Agno, Amburayan and Bued Rivers -- have been found to be heavily polluted with cyanide from tailings of mining operations. Such pollution and sedimentation have resulted in the decline of productivity of agricultural lands irrigated by these rivers, as well as losses to fishermen. Over 200 mines and quarries in the country discharge an estimated 190,896 mt of tailings and 371,644 t of mine wastes daily (Zafaralla 1982).

The pollution of the Pasig River in Metro Manila is a classic example of how a freshwater ecosystem has been decimated. Domestic and industrial wastes are dumped at the rate of 3,600 t and 30,137 gal, respectively, into the river and its tributaries each day. There are 313 industrial firms along the banks of the river in addition to the squatter families that discharge liquid and solid wastes (NEPC 1983)

Rivers in the other regions of the country in the Visayas and Mindanao have not been spared of the ravages of pollutive industries. In the Visayas, sugar mills and alcohol distilleries are responsible for the deterioration of rivers. The Hijo and Liboganon Rivers in Tagum, Davao del Norte were found to have high mercury levels with the tailings from gold mining operations (EMB 1990).

Aside from pollution and siltation, overfishing has also contributed to the decline of fisheries in our rivers inhabited by at least 234 Catadromous fishes (De la Paz 1988). As early as in the '30s, conservation of the **ipon** fisheries in Northern Luzon was already stressed (Montilla 1931). In the Cagayan River of Mindanao, the **dulong** (*Sicyopterus extraneus*) has been threatened not only by siltation of the river but also by too much fishing pressure (Manacop 1953).

Regulations for pollution control are enforced by the Department of Environment and Natural Resources through its Environmental Management Bureau, which is also tasked with monitoring water quality in our rivers. The DENR launched the Rivers Revival Program in 1987, initially with the **Ilog ko, Irog ko** Project, a multi-agency effort with the objective of lessening the pollution load of the Navotas-Malabon-Tenejeros-Tullahan River System of Metro Manila by 50% in 1992 (EMB 1990).

E. Fishponds and Small Impoundments

Fishponds are water-holding structures with dikes made of soil or concrete for growing fish and other aquatic species. Water supply for fishponds may come from rivers, irrigation or groundwater. The total area for freshwater fishponds in the country was estimated to be 13,847 ha in 1989 (BFAR 1990).

The largest concentrations of fishponds are found in Central Luzon and the Ilocos Region, with 9,114 ha and 1,342 ha,

respectively. Most of the fishponds are privately owned and have an average annual production of 2.47 mt/ha. The Nile tilapia is the main species of fish cultured, along with the common carp, shrimps and snails.

Two environment-related constraints that affect the freshwater pond industry are pollution of rivers and other waterways, and the introduction of exotic species. Fish kills in ponds occur when pollutants, such as agricultural pesticides and industrial wastes, contaminate fishponds through the water supply system. Polluted water has also been identified as one of the factors contributing to fish disease (De los Reyes 1986).

With the unsuitability of our freshwater endemic fishes for culture, there have been numerous fish introductions made in the country since 1905. A total of 34 exotic fish species have been introduced to date (Juliano et al. 1989). Most of these introductions have not had adverse impacts on the environmet. At least one introduced fish, the Nile tilapia, is now the second most important cultured fish in the Philippines.

On the negative side, however, our native freshwater catfish (*Clarias macrocephalus*) has disappeared in areas where its foreign counterpart (*C. batrachus* from Thailand) was released in the '70s. Similarly, the introduction of the freshwater snail, *Pomacea* sp., from South America in the early '80s, has resulted in the ecological displacement of our *Ampullaria luzonica*, a popular food item of the Ilocanos and Tagalogs. The "golden kuhol", as the foreign species is popularly called, has also become a major pest of irrigated ricelands in the country.

Small impoundments are dugout ponds or earthen dams with a height of 3 m or less. They are primarily built for rainwater storage and for flood and erosion control in the uplands. Water from these impoundments is used for agriculture, fisheries, power generation and recreation (PCARRD 1986).

A modified version of the upland small impoundment in the lowland is the small farm reservoir (SFR) for rainfed areas. The typical SFR has an average depth of 1 m, open water area of 0.2 ha and a water storage capacity of 2,000 cu m. Through such impoundments, rice farmers can earn additional income from a second crop of rice in addition to the fish production (Watson et al. 1988).

AN AGENDA FOR THE CONSERVATION OF OUR FRESHWATER ECOSYSTEMS

Our freshwater ecosystems provide us with many of our basic needs for survival and progress as a nation. It is imperative that we wisely manage these resources on a sustainable basis for the benefit of present and future generations of Filipinos.

The following eight-point agenda for conservation of our freshwater ecosystems is proposed.

1. Need for more studies on our endemic freshwater species and their ecology

We know very little about the biology and ecology of our endemic freshwater species. Their conservation and management can only be possible if we understand how they live and what they need to survive.

Our scientific literature contains mostly surveys and taxonomic information. Not much has been done in the areas of biological assessment, population dynamics and fisheries management of our natural freshwater ecosystems, particularly lakes, swamps and rivers. There is also a need for more researchers in the regions where such resources are found.

2. Need for strict enforcement of anti-pollution laws and fishing regulations, particularly for rivers and lakes

The existing laws and regulations for pollution control and fishing in our rivers and lakes need only to be enforced and revised, if necessary. This is crucial for us to be able to deal with the alarming trend in the high morbidity of our rivers and depletion of fisheries resources due to overfishing. Action is urgently needed in the provinces where little or no control is being done. Public support and political will for the conservation of the fisheries of our lakes and rivers are important.

3. Need for protection of endangered species

The endangered freshwater fishes and mollusks in the country should be propagated in protected and reserve areas to ensure their perpetuity and conservation for biodiversity. The Liguasan Marsh, and Lakes Lanao, Taal and Buhi are recommended areas for protection.

4. Need for greater public awareness and more information on conservation of freshwater ecosystems

Since people are the objects of management, people should be made aware of the urgent need for conservation and the consequences of unabated human stresses on the environment. Information drives should be done at all levels -- from kindergarten schools to the halls of Congress -- through the educational system and the mass media.

5. Need for more stringent regulations on the introduction of exotic species

To avoid further negative impact on our freshwater ecosystems, more stringent quarantine and import regulations for exotic species of aquatic organisms should be enforced. Qualified personnel and institutions should undertake evaluation and impact studies under controlled conditions on all introduced species before these are propagated and dispersed to ensure protection of our endemic species and the environment.

6. Need for more efficient water use in fishponds

With the increasing hectarage of freshwater ponds in the country, more efficient water use systems, such as integrated farming and recycling, should be considered.

7. Need for more small impoundments

One of the most effective and economical ways of conserving water and protecting the environment is to have more small impoundments in the country, particularly in upland areas where soil erosion is critical and living conditions of inhabitants are depressed. Aside from the conservation of soil and water, productivity of the land will be enhanced and nutrition of the uplanders will be improved.

8. Need for multisectoral and wholistic approach to freshwater ecosystems management

Management of freshwater ecosystems is a complex task that can best be done through the multisectoral and wholistic agroecological approach. The problems of siltation and pollution of the ecosystems can only be minimized with proper watershed management and waste treatment by industries. Overfishing of

the fisheries resources, on the other hand, cannot simply be solved by enforcing fishing regulations without considering socio-economic political factors.

Table 1. Freshwater Ecosystems of the Philippines

Ecosystems	Estimated Area (ha)
Lakes	200,000
Swamps	106,328
Rivers	31,000
Reservoirs	19,000
Ponds	13,874
Total	370,202

Source: Bureau of Fisheries and Aquatic Resources (1990)

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