
特集論文

Lake Lanao: An Ancient Lake in Distress

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Lake Lanao is located in the Province of Lanao del Sur, Autonomous Region in Muslim Mindanao, Philippines. It is one of the 17 ancient lakes of the world and used to be home to 18 endemic fish species that are not found anywhere else in the world. It is also the ancestral domain of the Meranao people and is the heart of the people's spiritual, cultural, social, political and economic life.

Keywords: Powerplants, Endemic Species, Watershed, Illegal Logging, Pollution

Lake Lanao is vital to the economic development of the communities around its shorelines, the island of Mindanao and the entire country, being the major source of hydroelectric power. Along the Agus River, the only outlet of the lake, are six hydroelectric powerplants arranged in a cascading series. The powerplants are owned and operated by the National Power Corporation (NPC). Altogether, the Agus grid generates an installed capacity of 727.1 mega watts (MW) of electricity, providing about 60% of the total electricity needs of the people of Mindanao and contributing significantly to the national grid. At present, Agus-3, another power plant midway along the Agus River, is under construction with a designed capacity of 225 MW. It is expected to be the biggest power plant in the Agus grid.

The watershed around the lake and along its associated rivers has suffered from rampant timber poaching and conversion to farms over the years. As a result, the water flowing into and from the lake has been reduced drastically. Soil erosion, sewage and agricultural run-off have also contributed greatly to the deterioration of water quality in the lake. Several endemic fish species in the lake have disappeared.

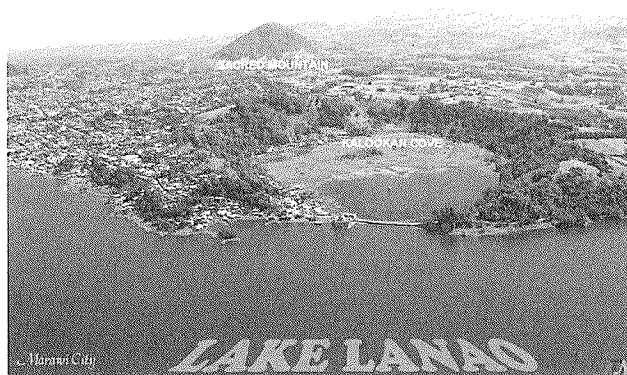


Figure 1 An aerial photo of Marawi City taken on 26 May 2008 by this writer onboard a military helicopter.

At present, the only industrial use of the lake is for power generation. In order to regulate and sustain the water flowing into the hydroelectric plants, the water level in the Lake is controlled. The fluctuation in the water level by a combination of natural and human factors has also contributed to the disruption of the Lake's ecological balance.

Local residents, the Meranaos, depend on the lake for domestic uses, including drinking water. Lake Lanao is

central to the history, culture and livelihood of the Meranaos, literally means "people of the lake". However, as an energy source, the lake is also a major contributor to the economy of Mindanao and the entire country.

1. Introduction

The clamor for preserving Lake Lanao arose in the latter part of 1990 as a result of the proposed commissioning and operation of the Agus-1 hydroelectric power plant. The project will, for the first time, make the Lake as a direct reservoir of the series of seven power projects along Agus river. Previously, the supply of water for energy generation was solely limited to the natural discharge of the river, the only outlet of the Lake.

Before October 1990, the National Power Corporation had been operating its five hydroelectric power plants along Agus River without any significant problem or serious opposition on the part of the community. A concerted action was launched to oppose the operation of Agus-1 hydroelectric power plant, the sixth and latest in a series of seven power projects planned along Agus River to tap the Lake Lanao resource.

Widespread expression of doubt, apprehension and suspicion against the opening of Agus-1 had come from practically every sector of the community. Agencies of the government directly involved in the affairs of the Meranaos and the Muslims expressed their concern in support of the move to stop the commissioning of the project.

2. Lake Lanao

2.1 Origin

It has been theorized that the Lake developed as a result of volcanic activity arising from tectonic movements. The formation of the basin could have resulted from depressed fault blocks caused by the movement of the underlying magma. According to Dr. Raymundo Punongbayan, Director of the Philippine Institute of Volcanology and Seismology, the volcanic origin of the Lake is evident from a geomorphological evaluation of the basin landform and its surrounding orography using imaging developed by remote-sensing

satellite.¹ This event which resulted into the formation of the Lake might have occurred during the late Tertiary Period according to David G. Frey of the Indiana University in Bloomington. Professor Frey headed the team which conducted an extensive limnological study of the Lake in 1967-68 while on assignment at the Mindanao State University as a Ford Foundation consultant.² The Tertiary Period is a geologic time division that ended about 10,000,000 years ago. Hence, the Lake might have been 10 million years old.

Frey also mentioned that G.E. Hutchinson, author of the multi-volume, *A Treatise on Limnology*, listed the Lake as one of the best examples of lakes formed by a lava dam.

2.2 Morphometry

The Lake can be roughly fitted to a right triangle with the Basak Area, or lowland plains, to the right of the upright leg, the Masiu-Ganassi line forming the base, and the Marawi-Ganassi line the hypotenuse. A line joining Balindong and Tamparan will divide the Lake into a shallow north (maximum depth of 55 meters) and a deep south (55 meters deep and greater).

Based on Frey's bathymetric survey, the deepest part of the Lake is offshore of Binidayan and Tugaya, just east of Balet Maito ("Smaller Island") with a reading of approximately 112 meters when the water surface was at elevation 701.89 meters above sea-level.

One kilometer away from the shoreline at Marawi is only 10 meters deep; a similar distance at Raman is 20 meters deep. Using this one-kilometer offshore distance gives the following approximate depths at other lake shore towns: Mulondo 20 meters, Taraka and Tamparan 40 meters, Masiu 60 meters, Lumbatan 93 meters, Binidayan 110 meters, Ganassi 45 meters, Bacolod 95 meters, Tugaya 90 meters, Balindong 45 meters, and Marantao 35 meters.

The Lake has a surface area of 35,468 hectares according to a field survey and planimetry measurement. It has a pondage volume of 21,254 cubic kilometers. Its mean depth (volume/area) is 60 meters. It had an average annual discharge at Agus River of 3,349 cubic

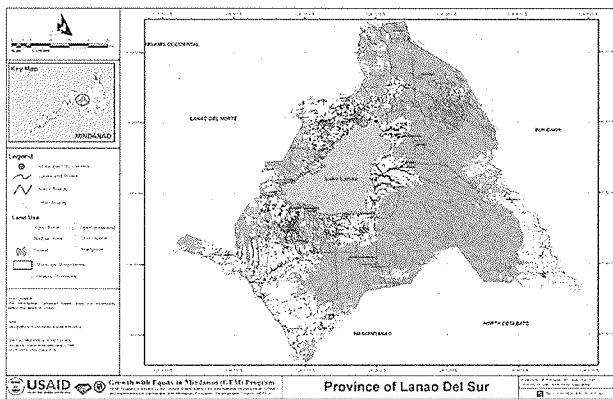


Figure 2 Map of Lanao del Sur, USAID

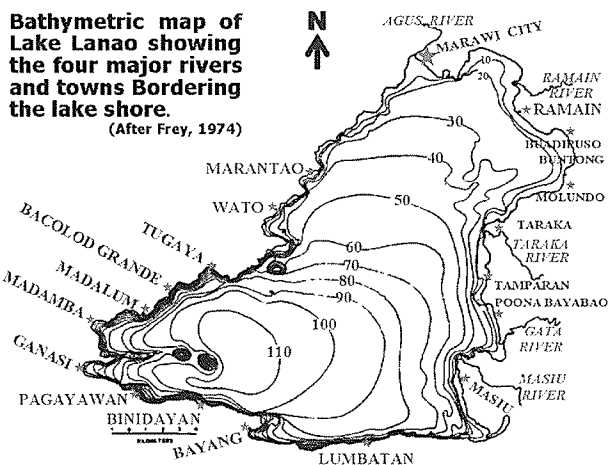


Figure 3 Enhanced bathymetric map of Lake Lanao sourced from David Frey.

kilometers and an average annual inflow from its tributaries of 3.343 cubic kilometers during the period 1950-1977 when there was free-flow.

The replacement or flushing period (volume/discharge) is 7 years and 4 months based on unregulated (natural) outflow.

2.3 Hydrology

The completion of the regulation dam in 1978 has altered the natural flow regime of Agus River and the hydrology of the Lake. The changes are evident in the hydrographic statistics summarized in the next paragraphs relating to the behavior of the water level and amounts of inflow and outflow before and after the installation of the regulatory structure.

The year-end average water elevation was 701.49 meters during the period 1950-77. With the regulated

discharge, the average water elevation was 700.91 meters during the period 1978-89.

The lowest level recorded during the period 1950-77 was 700.01 meters in 1973. The highest was 702.92 meters in 1955. The greatest fluctuation of the water level was 2.02 meters in 1955. After the dam, the lowest level occurred in 1979 at 699.25 meters, the highest in 1981 at 701.96 meters with the maximum fluctuation in 1979 at 2.59 meters.

A watershed area of 180,460 hectares naturally sustains the Lake. The terrestrial watershed has its greatest concentration at the eastern and southeastern part of the basin where the four great tributaries, Ramain, Taraka, Gata and Masiu rivers, derive their sources. The vast riceland of the Basak area is located on this section of the watershed. The southern, western and northern sections of the watershed contribute a marginal role in the maintenance and operation of hydrological processes.

3. The Meranao Lake

The term Lake Lanao is a redundancy of words because "Lanao" is merely a corruption of *Ranao*, a Meranao word for lake. To this people, this abundantly endowed body of fresh water has always been called *Ranao*, the Lake. The etymology of the resulting "Lake Lake" is an unhappy legacy from our colonial past. It is more accurate to use "the Lake" than "Lake Lanao." This special terminology is adopted in this report.

The attachment of the Meranao to the Lake is ingrained in his psyche: his identity and ethnicity are both derived from the same word for *the lake*. Perhaps a more succinct description of this relationship between a people and their watering place, so to speak, is this provided by an American writer:

" ... To the lake they have bound their identity: in their own eyes and in the eyes of the outsiders they are Meranaos, the People of the Lake. On its shores they established their villages and towns and built their mosques, with its water they purify themselves for prayer, in its wetlands they cultivate their rice, from its depths they gather fish, across its spans they transport goods and people, from it they take water for

drinking and cleaning. Each boulder and island in the lake, each hill and valley in the land surrounding it, is woven into the legends and epics of the people. And each Maranao can willingly trace his ancestry to the original *pat-a-phangampong* - four encampments on the lake, and their mythical founders. Thus it is with some justification and no little pride that the Meranaos consider the Lake Lanao "Our Lake."³

4. The Lake Lanao Watershed and the Agus Grid Powerplants

Lake Lanao watershed is located in Lanao del Sur and some portion in Lanao del Norte. It is a proclaimed watershed reserve by virtue of Proclamation No.871 issued on February 26, 1992 and is included in the initial components of the National Protected Areas System (NIPAS) governed under NIPAS Act of 1992 (Republic Act No. 7586).

Lake Lanao, with an area of 35,468 hectares, is the largest freshwater lake in the Philippines. Its water comes from five (5) sub-watersheds around it. These are: Taraka-Gata with an area of 55,000 hectares or 39% of the basin area, Malaig with 35,400 hectares (25%), Bubong with 19,500 hectares (14%), West with 17,500 hectares (12%) and Saguwaran-Marawi with 14,100 hectares (10%). Its outlet, Agus River, with a total length of 36.5 kilometers, cuts across the municipalities of Saguwaran, Pantar and Baloi and drains into Iligan Bay. Agus river supports six (6) hydroelectric power plants

of NPC with a combined capacity of 727.1 megawatts.

The Lake Lanao watershed includes Lake Lanao, about thirty rivers feeding water into the lake and the Agus river which is the only outlet of the lake. The four biggest rivers are Ramin, Taraka, Gata, and Masiu.

The National Power Corporation regulation dam started controlling the outflows of the lake to the Agus river in Marawi City in 1978. It consists of a 24-meter wide dam made of removable concrete blocks. During its construction about 70,000 cubic meters of river bed materials were dredged from the lake fronting the dam and the intake of Agus-1. The depth of dredged materials varies from three to five meters. The elevation of the base of the dam is about 695 meters.

Agus-1 hydroelectric power plant is located in Amai-Pakpak, Marawi City. Its construction cost is Php 2,441.7 million consisting of U.S. \$30.53 million or P854.14 million from foreign sources and Php 1,586.86 million from local sources.

It has two turbines of 40 mega watts (MW) capacity each or a total of 80 MW. Its powerhouse and turbines are located at about 97 meters below the ground level. These are constructed inside the twin pits which are open at the top. Their sides are protected by cylindrical walls made of heavily reinforced concrete. Its underground tunnels are located about 100 meters below the ground level and each is about 1.3 kilometers long. Its surge tanks were also constructed underground.

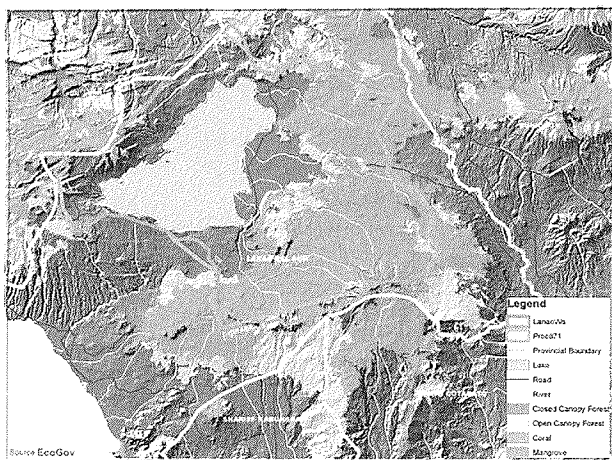


Figure 4 Watershed map of Lake Lanao, EcoGov.

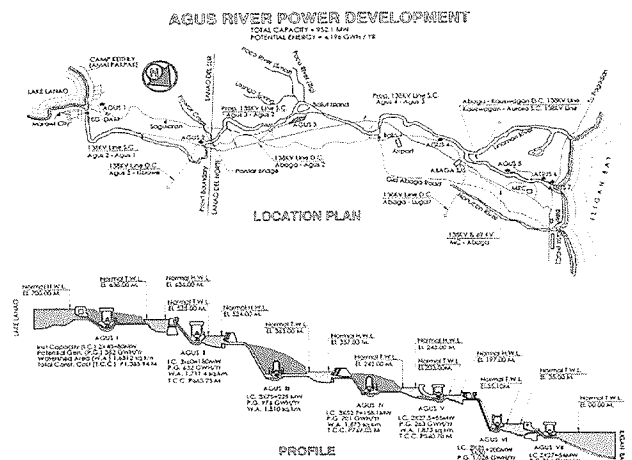


Figure 5 Agus River Power Development Plan. NPC MinGen

Table 1 The planned seven (7) power plants along the Agus river. NPC

HEP Project	Head or Drop (m)	Installed Capacity (MW)	Unit (Capacity) & Month/Year Commissioned
Agus 1	62.0	80.0	1 (40) 12/'91 2 (40) 12/'91
Agus 2	111.0	180.0	1 (60) 11/'79 2 (60) 09/'79 3 (60) 05/'79
Agus 3	161.0	225.0	1(75), 2(75), 3(75) for construction
Agus 4	115.0	158.1	1 (52.7) 3/'85 2 (52.7) 3/'85 3 (52.7) 4/'85
Agus 5	39.0	55.0	1 (27.5) 2/'85 2 (27.5) 2/'85
Agus 6	161.9	200.0	1 (50) 06/'53 2 (50) 10/'56 3 (50) 07/'69 4 (25) 04/'71 5 (25) 04/'77
Agus 7	35.1	54.0	1 (27) 03/'83 2 (27) 12/'82

5. Watershed Management

The watershed of the Lake has an area of 180,460 hectares, which includes the water surface area. A watershed is a distinct ecosystem or self-contained community of living organisms, including man, and their non-living environment, each influencing the properties and characteristics of the other and by necessity mutually dependent and interacting for the maintenance of life. The non-living environment consists of (a) inorganic substances like water, carbon, nitrogen, oxygen, etc., necessary for material cycles, (b) organic compounds like proteins, carbohydrates, humic substances, etc., that link the living (biotic) and the nonliving (abiotic) components, and (c) climate regime like temperature, light, and other physical factors.⁴ Water is an essential component and a dominant element in the environment.

Except for water bound up in certain sedimentary rocks, the surface water follows an unending sequence - called hydrologic or water cycle - of evaporation, precipitation, runoff and storage. The Lake is an example of storage.

The total amount of water from the atmosphere that reaches the surface of the watershed in the form of rainfall and drizzle is called precipitation. A part of this

water runs off directly into streams and rivers or travels through the uppermost soil layers and eventually ends in a stream channel that goes to the lake; this is called streamflow. Another part seeps down through the soil beyond the roots of vegetation and joins the water table, which also ends up in some underground stream channel leading to the lake or other small confinements; this is called groundwater. The bulk of the precipitation are evaporated back to the atmosphere from the surfaces of soil, ponds, rivers, streams, the lake, and from the vegetation as transpiration; this process is called evapo-transpiration. Measurement of this distribution has not been made as admitted by concerned agencies during the public hearings. In the United States⁵, this water cycle is 18% for streamflow, 10% for groundwater and 72% for evapo-transpiration.

The terrestrial watershed (land portion) is 132,370 hectares. It is bounded by the Lake shoreline and expands upland to the immediate topographic divide, or line joining the points of highest elevation. The divide forms the outer perimeter of the watershed. This area makes up the drainage basin that constitutes the main source of water inflow to the lake. The major portion of this terrain is on the eastern and southeastern side where the four great river tributaries are located. The forest cover is 64,460 hectares of commercial forest and 20,813 hectares of non-commercial forest, according to figures from the Bureau of Forest Management. The remaining areas consist of cultivated farmlands and open or brush lands.

The vegetative cover, more specially the forested section, is essential in the preservation of the water resource. It acts as storage by entrapping water in the upper crust of the soil which when sufficient in quantity forms the headwaters or source of streams and rivers. It also attracts cloud cover and induces precipitation. Without the vegetative cover, the soil will parch and become dry so that water from rainfall will not be stored. Instead, some of the water will be absorbed by the soil, some will be evaporated, but most will run off as agent of erosion bringing down scoured soil as silt and sediment into rivers and finally to the Lake. Siltation causes the

disappearance of rivers and consequently of lakes.

An area devoid of vegetative cover enhances the erodibility of the soil and weakens its resistance against erosivity. Erodibility (of soil) and erosivity (of rainfall) are the main factors affecting sheet erosion and soil loss.⁶

The proper management of the watershed is therefore a priority matter in the conservation of the Lake.

Testimonies of officials of the department of environment and natural resources assert that there is effective log ban in the area, that there has been neither swidden (kaingin) nor upland agriculture and that there has been no reduction of this forest cover since time immemorial despite the rampant logging operation in the area during the period prior to 1977, the year when the current ban on any form of logging in the watershed was effected. Reforestation programs are supposed to have been vigorously pursued.

It may not be far afield to deduce that the state of the forest cover and the rest of the watershed deteriorate in direct proportion to the apparent frivolous manner that management responsibilities are moved from one agency to another. Any program of conservation necessitates a continuity of effort, which can be effectively achieved if superintendence of its implementation is assigned permanently to only one specialized agency attending to no other dissimilar duties.

6. Environmental Degradation

Confusing laws and neglect from mandated agencies led to the destruction of its watershed and pollution of the lake.

The watershed around the lake and along its associated rivers has suffered from rampant timber poaching and conversion to farms over the years. As a result, the water flowing into and from the lake has been reduced drastically. Soil erosion, sewage and agricultural run-off have also contributed greatly to the deterioration of water quality in the lake. Several endemic fish species in the lake have already disappeared.

7. Institutional and Legal Issues

7.1 Legal Status of Lake Lanao

Lake Lanao and most of the surrounding watershed is located in the Province of Lanao del Sur, which is part of the Autonomous Region in Muslim Mindanao. The lake is surrounded by 18 municipalities and Marawi City. Two of the Agus powerplants are located within the province, while the other four are in Lanao del Norte.

Under the Organic Act of the Autonomous Region in Muslim Mindanao (ARMM), as amended, the Regional Government has jurisdiction over forestlands and waters within ARMM, with the exception of declared watersheds.⁷ Prior to the Organic Act, on February 26, 1992, the President of the Philippines issued a proclamation declaring the Lake Lanao area as a watershed reservation.⁸ The proclamation effectively excluded the Lake Lanao Watershed from the jurisdiction of the ARMM.

In June 1992, Congress passed the National Integrated Protected Areas Act (NIPAS). Under NIPAS, all declared watersheds were included as initial components of the protected areas system.⁹ The proclamation came before NIPAS and therefore, Lake Lanao Watershed is technically a protected area under the NIPAS system. Under NIPAS, Lake Lanao was to continue being governed under existing laws, rules and regulations. No law has since been passed reaffirming the status of Lake Lanao Watershed as a NIPAS protected area, nor has it been disestablished under the System.

NPC claims that it has complete jurisdiction and control over watersheds surrounding its powerplants and energy sources based on its charter.¹⁰ It is debatable whether NPC has actual control over the area. A memorandum order issued by the President following the proclamation in 1992 recognized DENR as lead agency, not NPC. NPC, in fact, entered into agreements with DENR and DENR-ARMM to manage portions of the watershed, recognizing the administrative jurisdiction of these agencies.

7.2 Current Management Framework

Following the proclamation of the Lake Lanao Watershed, the President created the Lake Lanao Watershed Protection and Development Council

(LLWPDC).¹¹ The Council is headed by the DENR Secretary, with the President of NPC as vice-chair. Council members include: AFP Chief of Staff, ARMM Governor, President of the Save Lake Lanao Movement, President of Mindanao State University, President of the Philippine Chamber of Commerce and Industry, and President of the Mindanao Association of Electric Cooperatives. In March 2007, the President added the following members: Governors of Lanao del Sur and Lanao del Norte, and the Mayor of Marawi City.¹²

The Council has not met regularly perhaps due to the incompatible schedules of the high-level membership. A major output of the Council was the approval of an Integrated Development Plan in 2003. The plan required an investment of P2.8 Billion in five years. It is not clear where the funds are to be sourced. From the reactions of the TWG, it is clear that the IDP has not been implemented as designed.

Despite the Lake being outside the jurisdiction of the ARMM, the Regional Legislative Assembly created a Lake Lanao Development Authority.¹³ There is some doubt if the regional law creating an Authority actually took effect in 1999. Most of the people in Lanao del Sur were unaware of the law. However, it is clear that the Authority was never activated and exists only on paper.

The Protected Areas and Wildlife Bureau of DENR is the agency primarily tasked with overseeing the management of NIPAS component areas. However, up to this day, PAWB has not made any significant steps to integrate Lake Lanao Watershed into the NIPAS System. In a conversation with PAWB officials, it appears that the agency has relied on Presidential initiatives in the area, most recently, the 2007 Proclamation reinforcing the Council with additional members.

The NPC has been the driving force in the Council. As part of its commitment, NPC allocated Php 10 Million for reforestation and watershed rehabilitation activities. However, these activities were limited to the Agus river and western side of the lake, where NPC had existing management agreements with DENR and DENR-ARMM. In talks with NPC, it became clear that when NPC speaks of watershed management in Lake Lanao, it only

refers to the northern Agus watershed area (around 13,700 hectares) and western portion of the lake (around 29,400 hectares). NPC has an existing MOA with DENR on the northern Agus area and with DENR-ARMM for the western watershed areas. The combined area where NPC concentrates is dwarfed by the total watershed area of around 194,000 hectares.

8. Options for Managing Lake Lanao and its Watershed

The key management considerations needed to effectively protect and conserve the lake and the watershed include:

- Capacity for integrated and science-based planning;
- Authority to regulate resource uses and development activities, consistent with the management plan;
- Capacity to monitor activities in the area and enforce management rules;
- Capacity to involve stakeholders in management activities; and
- Ability to sustain management activities from a reliable and sufficient funding mechanism.

The institutional and legal framework would follow, to address the management considerations above.

8.1 Co-Management Approach

Taking into consideration that the Lake Lanao Watershed is under the jurisdiction of the national government, and that the Council created by the President has not been as effective as expected, the Provincial Government took the lead by proposing a Co-Management agreement between the Province and DENR. A draft Co-Management MOA was prepared by the TWG where the Province and DENR share the responsibility of reviewing and revising the integrated development plan, regulating resource use and development activities and conducting enforcement actions against violators of environmental laws. The Co-Management framework is consistent with the policy of DENR in devolving watershed management functions.¹⁴

However, the co-management arrangement cannot fully

control the arbitrariness in the use of the local government share in the exploitation of national wealth and the ER 1-94 funds administered by DOE. Because these are entitlements given to the local government units, they have full discretion on the priority of use for the funds. Currently, most of the funding proposals submitted by LGUs under the ER 1-94 fund cover health projects and not watershed management projects. With incentives from the Provincial Government, component LGUs can be convinced to coordinate individual projects in order to be consistent with an integrated plan.

9. Conclusion

The most appropriate option is to push for the tripartite co-management agreement among DENR, ARMM and the Province of Lanao del Sur. DENR is receptive to the idea. ARMM will appreciate national recognition of its role in managing a critical habitat in the region, even though the lake is strictly outside of its jurisdiction. The Province is currently led by a pro-active governor who is intent on establishing a transparent and effective management system in the lake area. The co-management agreement should be negotiated and concluded as soon as possible.

Key activities under the co-management agreement may be implemented with the support of LLDA and NPC. LLDA has committed to provide technical assistance to the Province. NPC is receptive to include the key activities in its current and future proposals for watershed management under the environmental charge fund (EPIRA). With the co-management agreement, NPC will have stronger basis to participate in watershed management activities outside of its areas of concentration, particularly the eastern side of the lake where the tributary rivers are. NPC has also committed to share its technical expertise in GIS and IEC, among others.

Acknowledgment

I would like to acknowledge the support of several individuals that have helped me in one way or the other that brought me where I am now and hopefully to the

13th World Lake Conference.

Foremost is my family who supported me in my never-ending battle to protect and save Lake Lanao, an ancient lake that is being threatened by man.

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To Dr. Masahisa Nakamura, Chair, Scientific Committee, ILEC, who listened to my pleadings for help and came to Marawi City last September 2009.

References

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7. Republic Act No. 9054, Article XII, Sec. 5. Use, Development of Mines, Minerals and Other Natural Resources; Revenue Sharing; Exceptions. - (a) Regional Supervision and Control. The control and supervision over exploration, utilization, development, and protection of the mines and minerals and other natural resources within the autonomous region are hereby vested in the Regional Government in accordance with the Constitution and the pertinent provisions of this Organic Act except for the strategic minerals such as uranium, petroleum, and other fossil fuels, mineral oils, all sources of potential energy, as well as national reserves and aquatic parks, forest and watershed reservations already delimited by authority of the central government or national government and those that may be defined by an Act of Congress within (1) year from effectivity of this Organic Act.
8. Presidential Proclamation No. 871 (1992).

9. Republic Act No. 7586, Sec. 5 (a). xxx All areas or islands in the Philippines proclaimed, designated or set aside, pursuant to a law, presidential decree, presidential proclamation or executive order as national park, game refuge, bird and wildlife sanctuary, wilderness area, strict nature reserve, watershed, mangrove reserve, fish sanctuary, natural and historical landmark, protected and managed landscape/seascape as well as identified virgin forests before the effectivity of this Act are hereby designated as initial components of the System. The initial components of the System shall be governed by existing laws, rules and regulations, not inconsistent with this Act. xxx.
10. Republic Act No. 6395 (1971).
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