WATER RESOURCE UTILIZATION OF LAKE LANAO: ITS IMPLICATIONS TO SOCIOECONOMIC DEVELOPMENT

ABSTRACT

This study mainly aims to determine the modes of water resource utilization of Lake Lanao and how these relate to socioeconomic development of selected lakeshore and riverine municipalities of Lanao del Sur. Concurrent triangulation approach was the research design of the study involving 500 survey respondents and 16 key informants. Findings of the study indicate that the lake water has been used for domestic and economic purposes like energy generation, farm irrigation, and shell harvesting. On the other hand, the lake has become the sink of all types of wastes emanating from the residents resulting in water pollution. Moreover, the socioeconomic development of selected communities has little to do with the benefits accruing from the revenues generated from the establishment of the hydropower plants that gets water from Lake Lanao.

The study has significant implications to lake water resource governance, disaster resilience, and climate change adaptive strategies. Sustaining the quality of water resource for human consumption and other uses is challenged by anthropogenic activities that endanger the environmental sustainability of the lake. Appropriate and efficient management of Lake Lanao needs to consider the interconnections of the different ecosystems (water, land, forest) surrounding the lake through the ridge to reef or watershed approach to restore its integrity and ecological balance. The sustainable utilization of Lake Lanao water resources has bearing on the lake's current status and its ability to serve the needs of the immediate lakeshore communities and the hydropower demands of the increasing power users of Mindanao in the future.

Keywords: Lake Lanao, Meranaw, water resource utilization, water governance

Introduction

Water and its resources are a key factor in the survival, economic growth, and sustainable development of societies. It is a common resource that is open to access and potential over exploitation, if not "mis"exploitation by individuals, groups or corporations. Utilization of fresh water resources such as rivers and lakes come in the form of domestic, economic, cultural and the like.

Studies have shown that water resource quality and quantity can be threatened when it is used for purposes other than those that contribute to its health and sustainability. Domestically, among those that can be harmful is discarding or throwing of substances that may pollute or contaminate. Economically, water resource quality and quantity can be at risk when it is utilized as a driving force among others, to spur economic changes through the establishment of huge infrastructure facilities such as dams for water irrigation systems, for power generation, or for general water supply.

Community-based management has been adopted as a strategy for sustainable management of common resources, including water, under the Philippine Agenda 21, our national blueprint for sustainable development consistent with the sustainable development paradigm adopted by the United Nations Conference on Environment and Development (UNCED) to which the Philippines is one of the signatories.

This has proven effective as a mechanism for achieving sustainable resource as this allows stakeholders to exercise control and take on responsibility for the resource (Godgil and Burkes, 1991; Dyer and McGoodwin, 1994). In Thailand, this was exemplified by the Kanchamaburi Conservation Group's successful effort in opposing the construction of Nanchon hydel dam in Tung Yai Naresuan National Park, proposed by the Electricity Generation Authority of Thailand (Lopez-Wui and Banpasirichote, 2003). Similarly, the Cordillera People's Alliance, in pressing for tribal autonomy from the Central government, opposed and emerged triumphant over the construction of the World Bank funded Chico dam for electric power generation by the National Power Corporation (NPC) in the late 1980s (Drucker, 1988).

The Lake Lanao water resource has been utilized to generate power to supply the energy requirements of the Mindanao region since the 1950s. Presently, six (6) hydropower power plants cascade along the Agus River complex, utilizing water from Lake Lanao which flows to the Agus River and drains into Iligan Bay. According to their location from the mouth of Lake Lanao, these hydropower plants are the following: Agus I, Agus II, Agus IV, Agus V, Agus VI and Agus VII. One (Agus III) hydropower plant is still in the development stage. Situated at the Maria Cristina Falls, Fuentes, Iligan City is Agus VI, which was the first to be developed and completed in 1956, with additional units commissioned in 1956, 1969, 1971, and 1977. Its combined capacity is 200 megawatts (MW) (National Power Corporation; Itcheon,Segovia & Alcarez,1986).

As operationalized in the Lake Lanao-Agus River Complex, the cascade system is one in which a regulation dam of Agus I in Marawi City controls/regulates the water from Lake Lanao and releases it to Agus River. Given the various forms of human uses or activities undertaken in Lake Lanao which can have adverse impact on its water resources, the Lake Lanao watershed was declared a watershed reserve under the Proclamation No. 871 (February 26,1992) and the National Integrated Protected Areas System (NIPAS) Act of 1992 (R.A. No. 7586). On March 25, 1992 as amended by Memorandum Order No. 242 dated March 6, 2000, the Lake Lanao Watershed Protection and Development Council was created. This was intended to protect and ensure the efficient and optimum utilization of the natural ecosystems within the Lake Lanao Watershed.

With increasing population and thus power demand, alongside increasing global warming which could lead to critical reduction in lake water level, the need for effective management for sustainability becomes an urgent issue that needs systematic investigation. This study is an attempt to address this concern by looking into how the Lake Lanao water resources have been utilized during the full operation of the Agus hydroelectric plant complexes so as to determine how this has influenced the socioeconomic development of the selected communities in its immediate environs.

Objectives

This study mainly aims to determine the modes of water resource utilization of Lake Lanao and how these relate to socioeconomic development of selected lakeshore and riverine municipalities of Lanao del Sur.

Specifically, this study intends to do the following:

1. To describe how the Lake Lanao water resources have been utilized by the five municipalities and Marawi City at present considering that the the full operation of the government-owned and controlled six hydroelectric plants (HEPs) had already existed.

2. To determine how the Lake Lanao water resources utilization have contributed to the socioeconomic development of the five research sites

2.1 Economic Activities
2.2 Employment Opportunities
2.3 Municipal Government Income
2.4 Levels of living of Families

Theoretical/Conceptual Framework

The interrelationship between water resource use and socioeconomic and cultural development is a complex and multidimensional process constituting ecological, social, political and economic aspects. Taken from the perspective of sustainable water use, people must use water such that society is permitted to develop at the same time "flourish into an indefinite future without degrading the various components of the hydrologic cycle or the ecological systems that depends on it."(Botkin and Keller, 2003, p.402).

Like air, water is the key to survival, but access to it or no access to it can be a source of stress and conflict. And for almost very human endeavor, clean and safe water is vital. Thus, its availability points to where human activities are on this planet. Of all water on earth, 2.4 percent constitutes fresh water that is made up of all liquid fresh water, and 3 percent of this consists of readily available water in lakes, rivers, and streams (Cunningham, Cunningham & Saigo, 2005, p.359). One of the ten major water compartments, lakes, and reservoirs represent 0.009 percent of the earth's total water with an average residence time of 1 to 100 years, depending on depth and other factors (Ibid, p357).

Botkin and Keller (2003, p.297) classify water use as **off-stream use** and **in-stream use.** Off-stream use means removing water from its source, such as river, lake, or reservoir, for particular uses. Much of this is siphoned back to its source after utilization. One particular type of off-stream use is **consumptive use** where water is consumed by plants and animals or in industrial processes. In this case, water penetrates human tissue or products or evaporates while being used and does not go back to its source. On the other hand, **in-stream use** refers to use of rivers or lakes for navigation or transportation, hydroelectric power generation, fish and wildlife habitats and recreation, among others. The various sorts of purposes that in-stream use involve can lead to tension or controversy inasmuch as each type of use necessitates different set of conditions to avoid creating adverse effects. Consider for example, fish and wildlife need certain levels of water and rates of flow to be able to achieve the possible peak of biological diversity. In the case of hydroelectric power generation, this necessitates large fluctuations in discharges to address power needs, side by side with concern for conserving ecosystem health. Moreover, fish and wildlife needs for water pose potential conflict with needs for shipping and boating. The nature and quality off-stream use and in-stream use of lake, as well as, reservoir can be affected by human activities. Unfortunately, however, people may use the lake water or other water bodies in destructive way such as sites for dumping waste from domestic, economic and other activities. Through pollution water quality is degraded.

The aforementioned uses of lake water imply that sustainable development requires the continuous management of both the inputs and outputs of production and consumption. Inputs refer to food, living space and other resources. Outputs, on the other hand, refer to the waste and pollution that are generated (Barrow, 2006, p. 1989). Waste is defined as a movable material that once discarded can become a problem, hazard, or nuisance and it can lead to pollution. At other times, however it can take on further value. In this sense, pollution means "The introduction by humans, deliberately or inadvertently of substances or energy into the environment resulting in a deleterious effect" (O 'Riordan, 1995 cited in Barrow, 2006, p. 289).

In the context of sustainable development, socioeconomic development is viewed in this study as a combination of conditions that positively impacts the human wellbeing on a long term basis, cutting across generations now and in the future. Applying the concept to the context of the study, socio-economic development is operationalized with the use of a five-point scale in terms of these indicators, namely; a) Increased/improved economic activities, b) Increased local (municipality/city) government income, c) Increased family income, and d) Improved levels of living.

In the context of sustainable socioeconomic development, high levels of living must be a long-term and more or less equally obtained and enjoyed by people within generation and between generations in the current and future times.

Methodology

Basically utilizing concurrent triangulation approach, the study employed both quantitative and qualitative methods. Constituting the quantitative method is the key component of the study which involved a total of 500 respondents who were purposively selected using the maximum variation technique. On the other hand, qualitative methods include 16 key informant interviews, on-site observation, and secondary sources.

The key informant interview participants constitute the key officials, and members who represent their respective organizations, offices or agencies. They are considered key informants as they are knowledgeable of the functions, services offered, and existing risk reduction plans/activities of their offices. Organizations relative to Lake Lanao Watershed water resource utilization. The community resident key informants and survey participants were chosen from among those who have been living in selected research areas since the pre-establishment of the Agus Hydro Electric Plant complexes. The age of survey participants and of the KI was at least 50.

Results and Discussion

Modes of Lake Lanao Water Resources Utilization

This study is an attempt to document how the Lake Lanao water resources have been utilized and subsequently influenced the socio-economic development of the selected communities along the lakeshore and the along the bank of the river into which the lakewater drains.

Domestic Use

Lake Lanao water use is predominantly for waste disposal (23.1%) to include human waste, garbage and liquid waste, followed by washing clothes (15.6%), drinking (13.6%), watering garden plants (15.1%), then human bathing/swimming (12.8%), house cleaning (11.8%), and animal bathing (7.7%) (see Table 1). This is notable among respondents coming from Marawi City and Saguiran which are characteristically urban. However, a few others of those coming from Ganassi, Tamparan and Balindong also mentioned having used the lakewater for waste disposal.

The survey results on domestic use of Lake Lanao find support in the information generated from a key informant. An old man who is a long-time resident in Tuca, Marawi, claimed that the water from the Lake has been used in their family for drinking:

Another long-time resident in Marawi whose house is located near the Lake described how they draw water from the Lake for domestic purposes, thus:

> *The water from the Lake, especially in its deeper part of the Lake is clean. In previous years, family members would ride on a boat to go to the middle part of the Lake and fetch water for drinking. When water hose became available, we installed pump and attach a water hose in the middle portion of the Lake to draw water up to our house. In this way, we have obtained a steady supply of water at home.*

In Balindong, Lake water has provided the community with steady water supply through mechanization. This was narrated by an informant who resides in the locality:

> *There were politicians and rich persons who donated funds to our barangay to build water reservoir and installed a pump which suctions water from the lake to fill the reservoir. In this way, barangay residents will have steady supply of water.*

It has to be noted that not all respondents drink water from the Lake. Some 192 (38.4%) of them identified other sources of drinking water like spring, water system, bottled water, deep well, or a combination of these sources. Surprisingly, however, for those who drink water from the lake or use the lake for bathing, only very few reported they had problems or experienced bad effects like diarrhea, skin diseases and allergy. A minuscule also said that lake water is not safe for cooking nor is it clean enough to be used for ablution or to remove dirt of clothes or the smell of utensils even after being washed.

The issue on waste disposal use of Lake Lanao which adversely affects water quality in terms of pollution becomes even more critical when viewed in relation to other uses such as drinking and human bathing/swimming as these affect human health. On the other hand, washing clothes which involves the application of detergents adversely affects the fresh water quality and food resources such as fishes, shrimps, and crabs which are among the vital sources of protein and minerals that sustain people's health.

As of 2011, only 12.34% (or 9,006 households) of the total households in Lanao del Sur had sanitary toilets. And although Lake Lanao is the major source of potable water in the province, shortage of piped water is experienced by the 18 municipalities along the lake. The absence of water piping facilities and strong governance or regulatory measures to protect the lake puts more pressure on the quality and integrity of the lake water. These probably explained why Lake Lanao water is used as dumping area for all sorts of wastes and subsequently endangers the human health and well-being of lakeside residents.

Using the argument presented by Barrow, (2006, p.1989) that sustainable development necessitates the continuous management of both the inputs and outputs of production and consumption. In this sense, inputs refer to food, living spaces and other resources. On the other hand, outputs pertain to waste and pollution that are generated from production and consumption of goods. From a public health and ecological perspective, water pollutants especially the nonpoint sources such as untreated human and other wastes and sediments are considered health-problem causing ecosystem disruption (Cunningham, Cunningham & Saigo, 2005, p.379-387;Botkin & Keller, pp.423-430).

Cultural/Religious Use

The Meranaws being Muslim by religion predominantly utilize Lake Lanao water for ablution (52.8%). They also use lake water in a lot of their cultural practices like rituals (9.1%), thanksgiving or Kanduri (15.9%), healing (5.0%) or celebrations like marriage (10.1%), among others (See Table 2). In the study conducted by Mendoza et al. (2019), she identified the Meranaw traditional health practices along the lakeshore communities. Their respondents also pointed out that the absence of drinking safe water was one of the reasons why an individual becomes sick. Since the respondents were lakeside dwellers, they reported having difficulty in finding potable sources of water that adversely affected their health and well-being.

Using Botkin and Kellers's (2003, p.297) water use categorization as off-stream and in-stream, the case of Lake Lanao can fit into both categories. Off-stream use which is removing water from its source, has been illustrated through domestic/household and religious purposes while in-stream use is illustrated in some traditional healing rituals where the ceremonies are done in or near the Lake**.**

Economic Use

Information on economic uses of Lake Lanao water resources show a predominant pattern of in-stream use, although slight differences in specific in-stream use exist. These lake water uses are reported in the following percentage distribution: 1. electric energy generation (15.2%) mostly responded by those coming from more prosperous communities like in Marawi, Balindong and Saguiaran; 2. boating and other recreation activities (14.2%) pointed out by those coming from Ganassi where a port is situated and Tamparan, an agricultural municipality; 3. fish harvesting (12.8%) which is known more among respondents in Balindong, Tamparan and Ganassi but less in Marawi and Saguiaran; 4. travel/transportation (11.9%) noted among Tamparan, Balindong Ganassi respondents; 5. shrimp/crab harvesting (9.3%) mostly in Balindong and Ganassi; 5.farm irrigation (6.5%) in Balindong and Marawi; 6. bakery (5%) in Balindong and Ganassi, among others.

If some figures in Table 3 are going to be collapsed by type of lake water use and lumping altogether commercial/service and industrial activities like bakery, hotel, hospital and restaurant, the total percentage is 15.6%. It is much closer to those who said that lake water of Lake Lanao is used for energy generation (15.2%). Also, boating and other recreation activities (14.2%) and travel/transportation (11.9%) account for 16.1% and fish (12.8%) and shrimp/crab harvesting (9.3%) totals to 22.1%. These data would indicate that the lake water, first and foremost, provides ecological services like food for the lakeshore communities, mobility and transportation, electricity and commercial/industry needs.

Corroborating with the study of the UP Los Baños – College of Forestry (2014, unpublished), the data on waste disposal into the lake as a dimension of domestic and economic uses of Lake Lanao point to certain critical concerns about legislation and governance. Relevant laws have already been implemented about solid waste management (RA 9003) and pollution control and mitigation measures (e.g. P.D 856, P.D 825, RA 6969, P.D No. 1067) These laws are supposed to be made operational through appropriate local ordinances. One might also ask, To what extent have these laws been implemented? Has there been any systematic investigation to assess as to what extent has the implementation been effective? What implications do these have on lake conservation and management?

Lake Lanao Water Resource Contribution to Socio-Economic Development

Water is a precious renewable resource on which humans depend for survival and development, but development, on the other hand. can pose pressure and thus create adverse impacts on water quality and its resources. In terms of quantity, human water use increases with increasing population and development needs. Correspondingly, its availability and quality can be adversely affected by the myriad of ways by which humans pursue their quest for sustainable development in its holistic ecosystem perspective.

Lake Lanao water resource utilization is further looked into in terms of how it has contributed to the socio-economic development of the selected four lakeshore communities and one riverine before and during the full operation of the six hydroelectric plants along the Lake Lanao –Agus River Complex.

To what extent has Lake Lanao water utilization contributed to the socioeconomic development of the five selected communities? Is there any increase or decrease in contribution? Based on the concept of levels for living by Todaro (1977, p.415), little improvement in levels of living implies being able to barely meet needs for food, shelter and clothing. Needs for good health, education, leisure, other social and material wants may still be wanting.

Examination of the Lake Lanao water resource utilization contribution to socioeconomic development is outlined in the following dimensions of socioeconomic development, namely: 1) improved levels of living, 2) increased local employment opportunities, 3) increased/improved economic activities and, 4.) increased municipal/city government income.

Improved Levels of Living

If there is an aspect in the economic life of the communities that has moved up with the harnessing of hydropower energy of the lake is their levels of living. Respondents are in general agreement that they have experienced improvement in their water facilities; lighting system; educational opportunities in government, private and religious institutions; advanced/higher educational improved social conditions in terms of improved relations with family, neighbours, and government, improved recreational facilities and reduction in domestic violence; drainage system, and increased access to loan from government, private and religious institutions.

Based on the key informant interview data, Ganassi has been provided adequate piped water supply given the fact that it has developed five spring sources. In the case of Balindong, access to potable water is one of its acute problems. Piped water is available only for a few hours in a day, as stated by a key informant and as experienced by the research team members themselves.

As reported by the Department of Health in 2014 (cited in UP Los Banos – College of Forestry and Natural Resources, 2012), 91.73% (112, 057) of the households in Lanao del Sur had access to piped water. This scenario seems ironic when viewed in the light of the fact that Lanao del Sur through the Lake Lanao-Agus River Basin is the main source of hydroelectric power that supplies about 60% of the energy needs in Mindanao.

Just as the water facilities are lacking, the supply of electric energy has been rated inadequate. At the time of the study, the hydropower supply in the said communities was irregular, if not unavailable. In Ganassi alone, hydroelectric power supply was completely unavailable. The residents mainly used solar panels for their light and power needs. Only few families, however, can afford to install this costly electric power supply.

With increased educational opportunities provided by the government, particularly the Mindanao State University System, as well as, the private and religious institutions, advancement in educational attainment has been rated as having contribution to socioeconomic improvement. One obvious indicator of this is the heavy presence of tarpaulin banners along the roads displaying the advanced educational accomplishments and/or successful professional licensure or civil service examinations that members of their families/clans have achieved. Advancement in credentials is among the fundamental sources of social status and of their value for *maratabat* (the Meranaw concept of pride and self-esteem) which the Meranaw society greatly upholds at whatever cost, even at the point of losing one's own life.

There is also little improvement in relationships with family/clan members, neighbours, and government; and improved recreational facilities for children/youth, women, elderly, and men. Among the indicators of improvement of social conditions, reduction in domestic violence of family conflict is interpreted as having very little contribution to socioeconomic development.

Taken together, the social conditions present critical issues in peacebuilding and conflict management. Although family/clan solidarity as part of their principle or value for *maratabat* is orderly preserved of maintained, various forms of conflict exist among Meranaw. Conflict (or *rido* in Meranaw language) is characterized by sporadic outburst of retaliatory violence between families and kinship groups, as well as between communities (Alaya-ay et al. , 2013). One traditional form of struggle that has persisted despite their advancement in education and economic states is "rido" or family feud. *Rido* between families or clans has remained a classic feature of Meranaw society. It emerges and continues to exist until the last blood is dropped in defense of their *maratabat.* Various causes or conditions may trigger or escalate *rido*. These may take the form of assault or threat to their *maratabat*.

Further aggravating the social conditions of the Meranaw society is the proliferation of certain opposing groups in various localities of Lanao del Sur, such as the Islamic State of Iraq and Syria or ISIS-Maute Group, Mindanao Islamic Liberation Fron (MILF), and the Muslim National Liberation Front (MNLF) to name the major ones. These groups have established their respective territorial stations or seats in different areas of Lanao del Sur: apparently the ISIS-Maute group's home is in Butig, MILF in Balindong, and MNLF in Ganassi.

Increased Local Employment Opportunities

These local employment opportunities were available in fishing, farming, industry, government, and non-government organization. It was known that fishing and farming are the usual employment destinations of the locals, along with trade and commerce. Interestingly, there is an easing out of opportunities offered to the locals to industry and government especially after the operation of the hydroelectric plants along the Lake Lanao. Agus River complex. The operation and management of these institutions or sectors certainly necessitate functional power services. Increase in employment opportunities in these institutions or sectors suggest that hydroelectric power plant operation may have indirectly created local job opportunities. On the other hand, farming and fishing job opportunities remain least affected, especially among the municipalities of Balindong, Ganassi and Tamparan which are predominantly agricultural areas.

Although the hydropower plant operation would have benefited the residents in terms of availment of employment opportunities in the company, only few have managed to be employed and are now residing in other localities. The progress that one may observe among the residents may not be attributed to the hydropower plant operation, but perhaps due to overseas employment is their major source of income. Further, making the people's socioeconomic conditions worse is the fact that power service is not regularly enjoyed by the residents, and neither have they been afforded free electricity bill privileges since 10 years ago. This scenario is as true as it is the case of the selected communities.

Increased/Improved Economic Activities

The operation of five Agus hydroelectric power plant complexes may have partly contributed to increased trade and commerce in the selected communities, despite reports that some of these sites do not have steady supply of electricity. It is recognized, however, that the Meranaw are astute in business. This is a quality that makes them capable of adapting to changes in economic conditions whether locally or internationally.

Other economic activities that were noted to have varying positive increase are small-scale industries, cloth weaving , bags and *malong* making, jewelry making, mat weaving, brass making, food processing, furniture making, and building construction.

Increased Municipal/City Government Income

With increased economic activities and local opportunities for employment, it is expected that local government income would correspondingly increase due to taxation power of the four municipalities and city under the Local Government Code of 1991 (R.A. 7162). This is side by side with their commensurate Internal Revenue Allotment (IRA) from the national government. The results are encouraging in as much as the six components of local government income are concerned, specifically: 1.) taxation from industry, particularly the National Power Corporation and the National Grid Corporation of the Philippines, 2.) Small-scale industry, 3.) Trade and commerce, 4.) individual income tax, 5.) real properties, and 6.) share from the National Government (Internal Revenue Allotment).

On the whole, the five communities have increased their local government income from taxation and various sources. When properly and honestly utilized, this increase in income could bring about enhancement in the socioeconomic well-being of these communities. The fact, however, that only little contribution can be attributed to taxation implies that taxes are not correctly paid. One of the key informants revealed that in Lanao del Sur, people do not pay such taxes as income tax, business permits, building permits, and the like. Local government units through their appropriate offices do not strictly enforce the taxation policies. The residents, on the other hand, lack proper attitude towards proper payment of taxes. These concerns, however, need to be further substantiated through empirical study.

The establishment of hydroelectric plants along the Lake Lanao – Agus River complex was inspired by the desire, among others to cater to the demand of increasing population towards achieving sustainability in providing the necessary socio-economic services to achieve development. This is, however far from realized after a span of more than 39 years since the start of operation in 1953 so far as the selected communities are concerned. With the addition of one more hydroelectric plant (Agus I) at the mouth of the Lake in Marawi City in 1992, alongside the declaration of the Lanao Lake watershed as a watershed reserve together with the creation of the Lake Lanao Watershed Protection and Development Council, the overall positive socioeconomic changes even after the additional span of about 34 years in the selected communities have remained low particularly in the areas of increased economic activities, local employment opportunities, and municipal/city government income. Interestingly, it is only improved levels of living in which the respondents rated the Lake Lanao water resource utilization as having moderate contribution.

Conclusion

In this study, we examined the ways by which Lake Lanao water resources have been utilized and how such utilization has enhanced the socioeconomic life of the selected lakeshore and riverine communities. The main purpose is to determine how the lake resource health and sustainability have been threatened by human activities including the disposal of waste and the establishment of hydroelectric power generation. In this way, empirical bases can be established for developing strategies for sustainable management of the Lake Lanao water resources and for effective governance of the selected lakeshore and riverine communities towards achieving resilience and sustainability. This is on top of enriching the scientific knowledge capital concerning the detrimental effects of mis-use, if not over exploitation of an open access common resource such as Lake Lanao.

With five selected lakeshore and riverine communities as research sites, this paper describes the modes through which the Lake Lanao resources have been utilized domestically and economically and how these has contributed to their socioeconomic development upon the current full operation of the six hydroelectric plant complexes.

The study has significant implications to lake water resource governance. Sustaining the quality of water resource for human consumption and other uses is challenged by anthropogenic activities that endanger the ecological sustainability of the lake. Degradation of Lake Lanao water quality has also subsequently affect the population who are dependent on the lake for food supply. Appropriate and efficient management of Lake Lanao needs to consider the interconnections of the different ecosystems (water, land, forest) surrounding the lake through ridge to reef or watershed approach. The observed decline on the forest cover of Lanao del Sur due to varied anthropogenic activities (illegal logging, faming and other forms of destruction) and their subsequent effects on the lake quality need an integrative management strategy and

There are six hydropower plants that are now operational and make use of water from the lake. The establishment of these plants has been conceived to be drivers of the socio-economic development of the residents and communities living around the lake. However, the data on the perceptions of the respondents on the socio-economic development role of the lake do not show appreciative improvements in trade and commercial development or their employment opportunities in the various sectors. Inversely, however, there is improvement in their community facilities, levels of living, and educational opportunities among the residents.

The findings have important implications to water resource governance which call for the efficient implementation of laws that protect the integrity and ecological balance of Lake Lanao. Moreover, the results have very significant contribution in analyzing the ecosystem, or watershed approach or “ridge-to-reef” approach in situating the data generated by this study. The sustainable utilization of Lake Lanao water resources have bearing on the lake’s current status and its ability to serve the needs of the immediate lakeshore community and the hydropower demands of the increasing power users of Mindanao in the future.

Recommendations

Lake Lanao is a vital and irreplaceable resource not only for the Meranaw but also for Mindanao and the Philippines as a whole. Based on the survey and key informant interview results, it is at risk from non-point pollution from wastes, dwindling fishes, destruction of fish habitats, water diversion for energy generation, agricultural and other economic activities, terrorism, among others. These factors can adversely affect the water quality and resources available for consumption in lakeshore communities, water quantity for energy generation and other economic and socio-cultural activities for Mindanao and

the entire country. In short, these factors pose an enormous threat to human security and well-being and to the lake ecological integrity. It is in this context that the following courses of actions are forwarded:

Policy Action/Intervention

1. Water-related problems are human-made, and thus require a national and regional fresh water ecosystem restoration and management policy and program. Inasmuch as these are already in place what is needed perhaps is a thorough review for possible revision and strengthening.

2. The Lake Lanao Development Authority as the main organization that will review/formulate, implement, monitor and evaluate the implemented policies and programs relative to the restoration and management of Lake Lanao.

3. It is recommended that the local government units will implement the ordinances pertaining to Lake Lanao preservation, clean water, Waste Disposal Management.

4. It is also recommended that educational institutions and even religious personalities particularly the *imams* will help in propagating the importance of preserving and taking care of nature like Lanao, of maintaining cleanliness and sanitation in the surrounding, household, and personal level, as well as proper waste disposal.

5. Alternative livelihood sources for the lakeside communities especially during the occurrence of natural and climate change –related disasters.

Areas for Research

1. Initiatives to recover or enhance the quality of a lake is conditional on a systematic and holistic diagnosis and evaluation before undertaking restoration interventions according to a G.D. Cooke, E.B. Welch, S.A Peterson and S.A. Nichols (2005, p.47). This is necessary to identify the lake problems and their causes, their current state and security. This may be done periodically to be able to craft not only reactive but practice measures.

2. In the light of transdisciplinary/interdisciplinary stakeholder approach, the diagnosis/feasibility studies must be undertaken using watershed approach. Lake quality is directly affected by its location within the watershed that feeds its landscapes and nutrients, as well as, sediments. With the aid of the geographic information systems, the basic characteristics of the lake can be determined to explain its condition in the context of the attributes of the watershed within which it is located in addition to the lake area volume, depth contours, stream flow, ground water, lake level, and other characteristics; wastewater, suspended solids, nutrient concentrations, other physical, chemical and biological components need to be determined as well (Ibid., pp.47-57).

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Practical Application

1. Human activities relative to Lake Lanao water resources utilization must be subjected to operation and management control, direction and influence, by strictly enforcing relevant laws such as the ecological solid waste management (RA (9003) Water Code of the Philippines (PD 1067). In this way, inappropriate and destructive practices such as waste dumping, use of illegal fishing methods, and the like would be curtailed, if not minimized, within the watershed and the lake ecosystem.

2. To effectively address the wide array of interconnected human and natural resources problems confronting Lake Lanao and the surrounding communities, the process of formulating and implementing appropriate courses of action must be integrated, holistic, inclusive, and participatory with due consideration for the ecological, sociocultural, economic, political and institutional aspects of the ecosystem.

3. Power services need to be extended to all the Lake Lanao communities in the spirit of equity, accountability and inclusiveness principles.

4. Terrorism may be averted/prevented by raising the awareness of Lake Lanao people to value, promote, strengthen and sustain Filipino solidarity, peaceful coexistence, respect for human rights, social justice, human well-being and ecological integrity, among others. This can be attained through intensive informative education and communicative intervention.

5. The Lake Lanao Watershed Protection and Development Council has been in existence for about 25 years. It is thus logical that it be subjected to evaluation to identify areas from environment.

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Appendices

Table 1. Domestic Use of Lake Lanao Water

Meranaw Communities												
Domestic Use	Marawi City		Saguiran		Ganassi		Tamparan		Balindong		Total	
	n	%	n	%	n	%	n	%	n	%	N	%
Fetching water for drinking	61	12.7	72	12.2	65	11.3	82	17.4	85	18.1	365	13.6
Washing Clothes	88	18.4	82	13.9	83	14.5	80	17.0	85	18.1	418	15.6
Fetching water for watering of garden plants	65	13.6	68	11.5	62	10.8	67	14.2	44	9.4	406	15.1
House Cleaning	64	13.4	65	11.0	72	12.6	71	15.1	44	9.4	316	11.8
Human Bathing/ Swimming	74	15.4	69	11.7	78	13.6	65	13.8	56	11.9	345	12.8
Animal Cleaning/ Bathing	37	7.7	55	9.3	41	7.2	17	3.6	58	12.3	208	7.7
Waste Disposal	30	6.3	52	8.8	62	10.8	26	5.5	45	9.6	215	8.0
Human Waste	23	4.8	48	8.1	49	8.6	24	5.1	24	5.1	168	6.3
Garbage Solid Waste	20	4.2	41	6.9	45	7.9	20	4.2	21	4.5	147	5.5
Liquid Waste	17	3.5	35	5.9	12	2.1	16	3.4	8	1.7	88	3.3
Toxic/ Infection			3	0.5	4	0.7	3	0.6	0	0.0	10	0.4
Total	479	100.0	590	100.0	573	100.0	471	100.0	470	100.0	2686	100.0

Table 2. Cultural/Religious Use of Lake Lanao Water

Meranaw Communities												
Cultural / Religious Use	Marawi City		Saguiran		Ganassi		Tamparan		Balindong		Total	
	n	%	n	%	n	%	n	%	n	%	N	%
Rituals	3	3.2	10	16.9	12	9.8	14	12.4	3	3.9	42	9.1
Healing	4	4.3	9	15.3	5	4.1	1	0.9	4	5.2	23	5.0
Thanksgiving	17	18.3	9	15.3	20	16.4	21	18.6	5	6.5	72	15.5
Ablution	41	44.1	25	42.4	64	52.5	53	46.9	62	80.5	245	52.8
Conflict Resolution	5	5.4	0	0.0	4	3.3	2	1.8	3	3.9	14	3.0
Marriage	14	15.1	3	5.1	12	9.8	18	15.9	0	0.0	47	10.1
Birthing/ Child Delivery	9	9.7	3	5.1	3	2.5	4	3.5	0	0.0	19	4.1
Kandori	0	0.0	0	0.0	2	1.6	0	0.0	0	0.0	2	0.4
Total	93	100.0	59	100.0	122	100.0	113	100.0	77	100.0	464	100.0

Table 3. Economic Use of Lake Lanao Water

Meranaw Communities												
Economics Use	Marawi City		Saguiran		Ganassi		Tamparan		Balindong		Total	
	n	%	n	%	n	%	n	%	n	%	N	%
Farm irrigation system	20	7.7	21	8.0	15	3.5	19	8.4	30	7.0	105	6.5
Poultry raising	8	3.1	9	3.4	18	4.2	4	1.8	17	4.0	56	3.5
Cattle raising	6	2.3	5	1.9	13	3.0	2	0.9	23	5.3	49	3.0
Fish harvesting	27	10.4	18	6.9	58	13.5	40	17.7	63	14.7	206	12.8
Shrimp/ Crab harvesting	16	6.2	7	2.7	45	10.4	15	6.6	66	15.3	149	9.3
Shell Harvesting	14	5.4	6	2.3	25	5.8	8	3.5	35	8.1	88	5.5
Seaweeds	5	1.9	8	3.1	4	0.9	1	0.4	32	7.4	50	3.1
Electric Energy Generation	63	24.3	53	20.2	30	7.0	37	16.4	61	14.2	244	15.2
Industry	3	1.2	7	2.7	11	2.6	0	0.0	5	1.2	26	1.6
Commerce/Trade	6	2.3	13	5.0	17	3.9	2	0.9	3	0.7	41	2.5
Hospital	14	5.4	7	2.7	5	1.2	0	0.0	0	0.0	26	1.6
Restaurant	12	4.6	14	5.3	25	5.8	2	0.9	0	0.0	53	3.3
Bakery	10	3.9	21	8.0	46	10.7	0	0.0	3	0.7	80	5.0
Hotel	5	1.9	4	1.5	13	3.0	0	0.0	3	0.7	25	1.6
Travel/ transportation	20	7.7	31	11.8	48	11.1	30	13.3	51	11.9	180	11.2
Boating and other Recreation Activities	30	11.6	36	13.7	58	13.5	66	29.2	38	8.8	228	14.2
Market	0	0.0	2	0.8	0	0.0	0	0.0	0	0.0	2	0.1
Total	259	100.0	262	100.0	431	100.0	226	100.0	430	100.0	1608	100.0