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Policy Development for Environmental Sustainability of Agus-1 Hydroelectric Powerplant in Marawi City, Philippines

Jalaloden M. Motalib[1*], Kristine D. Sanchez[2]

[1]Department of Civil Engineering, Mindanao State University, Marawi City, Philippines
[2]Department of Civil Engineering, MSU – Iligan Institute of Technology, Iligan City, Philippines

**Corresponding author: jalalmotalib04@gmail.com*

Abstract: Agus-1 Hydroelectric Powerplant is located within the mouth of Lake Lanao. This set-up is the most affecting factor which deteriorates the environmental health of the lake. In this reason, this study was conducted to assess the environmental sustainability of the lake and to generate policy development which is appropriate for implementation. The researcher collected data through water sample testing supported by survey instrument and focus group discussion. There were 200 respondents of the survey and it was found out that there is a consistent trend of those who rated no impact to low impact to all the sustainability indicators dictated. The results proved that the mandated agencies were ineffective and that the programs for re-vegetation, conducting fertilizing, seeding and plant tree seedling around the hydropower were not sufficient to keep the preservation of forest around the plant. Also, the water quality test results revealed that there was a presence of fecal coliforms, indicators of contamination of water in Lake Lanao. Thus, after data were extracted, the policy development was designed in focus of Environmental Excellency and Watershed Management.

Keywords: *Agus-1, Environment sustainability, Hydroelectric powerplant, Policy development, Water quality testing*

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1. Introduction

Hydro power development creates an enormous ecological disruption on different rivers from different regions such as; sharp declines in available freshwater due to dam construction drive, seasonal changes in river discharge as well as loss of downstream freshwater habitat, floodplains, and even coastal erosion and salinity changes. According to Moran et.al (2018), the negative consequences of hydropower dams for ecosystem structure and composition and function can be more severe. A such having Agus 1 Hydroelectric Powerplant in Lanao del Sur, Philippines is both an answer to a local sustainable renewable energy and a challenge against the environmental welfare of the community.

The Agus-1 Hydroelectric plant is located in Marawi City, Philippines in the farthest portion of the upstream section right in the mouth of Lake Lanao. These power plants serve as a source of power within Marawi City and its nearby barangays (Hansel & Metillo, 2016). It basically provides potable water for all residents, sustained agricultural production, protection of the city in environmental flow under ordinary conditions and possible extreme conditions, security of the availability of adequate water, and electricity supplies for growing industrial, recreational, and commercial development activities in Marawi City (NPC ESIA, 2020). However, despite the aforementioned benefits that this power plant brings, the Agus I power plant needs to be given cautious care in order to sustain and maintain its resources for the future generations, thus a sustainability study.

Environmental Risks during the operation of Agus-1 Hydroelectric Plant

In compliance for Environmental Compliance Certificate (ECC), the National Power Corporation is mandated to routinely monitor the comprehensive environmental implementation and water quality of Lake Lanao near the Agus-1 during its operation.

Land

During the operations and maintenance of Agus-1, it is recorded that the power plant had produced solid wastes coming from the facility and its workers. In the report of

National Power Corporation (NPC) during their Impact assessments in the year 2020 as a requirement for the maintenance of the powerplant, soil contamination had occurred due to accidental fuel or oil spillage. Also, there had been moderate soil erosion due to the activities of the powerplant such as replacement and repair of hydromechanical equipments (NPC ESIA, 2020). In fact, Cuna & Sheen (2016) also discovered that the issuing of Transport Permits for the hauling of hazardous wastes and Importation Clearance for substances were not on the Priority Chemical List as part of the implementation of RA 6969. Although Del Rosario (2000) explained that in this act offers the legislative basis for the Philippines' systematic, comprehensive, and ecological solid waste management program which will assure public health and environmental protection, the implementation is very unclear. This information gives a mirror-like research to that of the study of Humagain & Shrestha (2020) which focused on the effects of generation dispatch orders on the system parameters in the condition of INPS or Integrated Nepal Power system which emphasized the import and export modes, problem, and issues and their effects on the system parameters under the plan in INPS.

Water

Confusing laws and neglect from mandated agencies led to the destruction of its own watershed and pollution of the Lanao Lake (Naga, 2011). There were existing detrimental environmental problems because of the presence of the hydropower dams in the lake lanao such as Hazardous materials (e.g. PCB's, Batteries, used oil) used in the operation of the Turbines of the power plant which may had contaminated the lake lanao near the Agus-1 (NPC ESIA, 2020). As evidenced, in 2006 a water sample from the lakeshore near the Agus-1 was tested and it was found out that the lake water was contaminated with fecal coliforms and bacteria (Lagmay et al, 2006)), an indication that there was indeed environmental consequences and that Agus-1 hydroelectric plant had affected the water quality of Lake Lanao. This was also proven in the study of Hansel and Metillo (2016), they had stated that the establishment of the Agus-1 hydroelectric Plants caused the occurrence of the Eutrophication of the Lake by Algal blooms from which it had impaired the water quality of the lake and affect the habitats, fisheries, both in the reservoir and downstream (Environmental, Climate and Social Guidelines on Hydropower Development, European Investment Bank, 2019). Also, in the study of Angagao et.al (2017), it was identified that the water depth, air temperature, the amount of shade, and thermal pollution from human activities were all elements that contributed to the temperature change of the lake water. These conditions will endanger the health of the resident and the aquatic animals (World Bank, 2020).

Hansel and Metillo (2016) stated that the nature of Agus-1 was a different matter compared to the other Agus Hydro power plants. Agus-1 was not built along the Agus River but on the Lake Lanao itself near the Marawi Lake which in effect making the lake as its own reservoir. Also, it did affect the lives of the people inhabiting the lakeshore areas and the environment such as fisheries, natural habitats, and forest around the lake. On 1992 the Lake Lanao Watershed Protection and Development Council (LLWPDC) was formed in charge of formulating Policy Regulations to address the issues attached to the Agus-1 but such tasked was neither been implemented nor completed due to budgetary constraints and/or political circumstances as of date.

The current state of Lake Lanao was also caused by several problems such as poor health services, increasing population, insufficient institutional capacities to implement and mandates for the operation of Agus Phase I, and limited collaboration over the lake Lanao management of the various natural stressors including flood and landslides. The socio-economic problems caused by the construction of hydropower dams are immense; the living conditions and food security of communities living near the hydropower dams downstream are often placed in peril, the fish catch declined by 60% almost immediately, and thousands of people living near the hydropower dam were affected by the loss of fisheries, flood recession agriculture, and other natural resources (Scudder, 2011).All of which are due to the inefficient observance of the Policies and Regulations which must actually be implemented along with the uprising demands of the use of the resources. However, the roots of these problems are actually from the fact that there is no exclusive and immediate policy guidelines which is intended for the Agus 1 stakeholders and residents to follow.

As such, there is a need to check the current quality of the lake water to measure the extent of enforcement of the watershed management mandated to the National Power Corporation (NPC) and DENR in order to propose a policy regulation to sustain the Lake Lanao preservation for future generation. Although there are various research which had assessed the environmental state of the Lake Lanao, the researcher found research gaps across those articles which are; the lack of tangible recommendation appropriate to combat the problem and the involvement of the consumers in the assessment of the environmental sustainability. For the past consecutive years to date, there has been an overwhelming drop of the water quality of the lake. There must be a tangible output which could assist the implementation of discipline and regulatory functions. Because of this, this present study aimed to develop a policy regulation after an assessment of the environmental sustainability of the said plant. This was conducted by primarily assessing the water quality of the lake, and performing survey and focus group discussions to substantiate credible information.

2. Materials and methods

The Agus I Hydroelectric Power Plant is geographically located in Marawi City, Lanao del Sur, Philippines, with coordinates 8.00 degrees latitude and 124.29 degrees longitude. This infrastructure is of type hydropower plant with a design capacity of 80 Mwe (megawatts electric).

Figure 1: Location of Agus 1 Hydroelectric Plant

The lake of Lanao, where the Agus phase I is located, is mainly made up of 121, 984 hectares of forestland. Alienable and disposable land accounts for around 41,305 acres or 21% of the total land area. Except for the Masiu sub-watershed, the lake is surrounded by Alienable and Disposable lands.

Survey Checklist

The self-constructed survey Checklist was composed of items which will be evaluated through the respondents's knowledge and perception for the environmental sustainability of the Agus 1 Hydroelectric Powerplant. The indicators used for the survey in terms of environmental sustainability were the following areas: (a) Educational awareness of the people about the power plant; (b) Development economic opportunities from improving the ecosystem; (c) Construction of Fish ladders; (d) Implementation of programs that protect the lives of the residents; (f) Constructing engineered landfills; (g) Establishing road access to protect wildlife; (h) Protecting areas with important landscape features; (i) Implementation of re-vegetation programs; Design measures to keep contaminants and pollutants away from Lake Lanao. Afterwards, additional value information was gathered through Focus Group Discussion from the randomly selected respondents to further support the data findings on the survey.

Water Samples for Water Quality Assessment

There were three water samples established from three different stations of the same day for the water quality assessment. Station 1 was situated at the Brgy. Raya Madaya 1, Station 2 was at the Brgy. Bubonga Marawi near at the mouth of Agus 1, Station 3 was at Baranggay Bacolod Chico Proper.

Figure 2: Location of water sampling Stations

Data Gathering

The researcher maintained close coordination with the main stakeholder agencies. These stakeholders included the Department of Environment and National Resources (DENR) field offices, Local Government Units of Marawi City, and the Department of Agriculture (DA), Marawi City Water District. Since the researcher aims to develop a policy recommendation, the organizations mentioned above were able to contribute to the study by providing the researchers with important documents, comments, and suggestions.

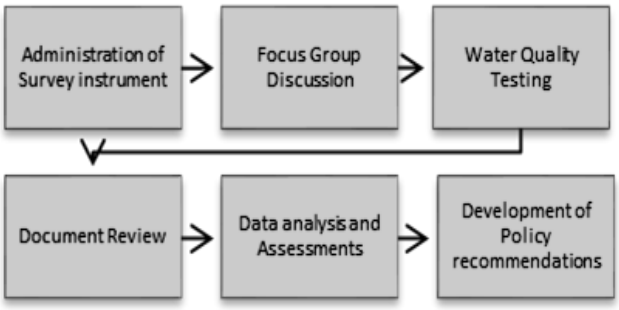

Figure 3: Data gathering procedure outline

Figure 3 illustrates the outline of the data gathering procedure that was used in this study to develop the exclusive policy guidelines that was specifically designed for the sustainability of Agus-1 hydroelectric power plant.

Administration of Survey Questionnaire

The Fishbowl or lottery sampling method which was used in this study avoided bias and a one-sided participation of many populations which is discouraged in this type of research. To ensure there was no bias in selecting respondents for this study, the researcher wrote down each names of the barangays on a slip of paper, folded it and placed it in a fishbowl in order to provide equal opportunities for the barangays to participate in this study. In this way, the researcher made it easy to identify the location from which the survey will be conducted. The research-structured survey checklist was used in this study and was translated to Maranao to obtain more reliable response and information from the target respondents. The answering of a survey questionnaire was estimated to be finished within 10-15 minutes per respondent.

The number of respondents who were residing in the coastal areas were given a larger focus compared to the upland barangays. The percentage distribution is 60 to 40 percent; 60 percent for the coastal areas and 40 percent for the upland areas, respectively. The researcher opted to consider larger number of respondents coming from the coastal areas for the very reason that residents in these areas experience an irrefutable first-hand experience of the environmental factors caused by the operation of the Agus 1 Phase 1 Hydroelectric powerplant.

The survey data were tallied, tabulated, calculated, and analysed for the proposed medication of the policy output. The presentation of the data is supported by the answer obtained from implications analysed from the supporting data collected from the focus group discussion. Settlement

patterns, income, conflict, provision of social services, land rights, and other socio-economic aspects were analysed and examined. To formulate a human development policy for the stakeholder of the Agus phase I, the analysis focused on the sustainability of the operation of the power plant, which aimed to improve the quality of life of the residents.

Water Quality Assessments

The bio-ecological assessment has also been conducted, including the water quality assessment in Lake Lanao following the Philippine National Standard for Drinking Water. In this way, the study was able to measure the extent of enforcement of regulations or policies imposed by the National Power Corporations in preserving and protecting the Lake lanao watershed from pollution from land-based sources as mandated by the Philippine Clean water act of 2004.

Three water samples for pH, Nitrate, TDS, Color and Turbidity analyses were collected at the three stations and was placed in three sanitized glass jar, labelled with station numbers and sample names. The samples were placed in a Cooler box with ice to minimize contamination and were brought to Water-Life Laboratory Water Testing Services for testing and analyses. The same samples were duplicated per stations for its microbiological testing in the same laboratory.

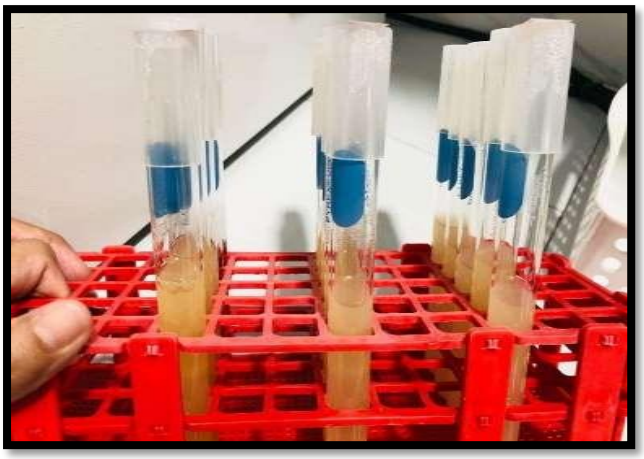

Figure 4: Confirmatory test for Fecal Coliform

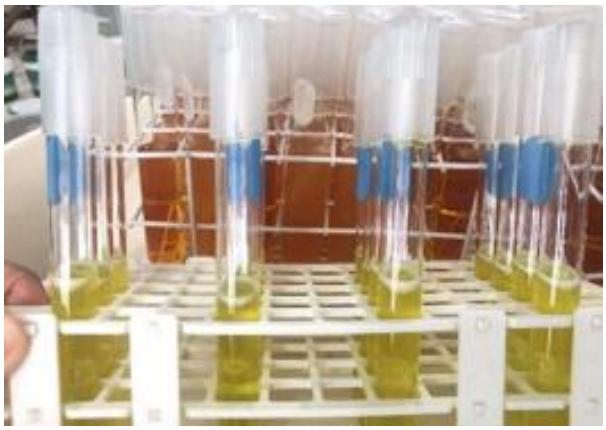

Figure 5: Confirmatory test for Total Coliform

The following methods were performed for each parameters used in the testing of the three samples:

Table 1: Method for Physical-Chemical Analysis for water quality testing

Parameters	Method	PNSDW 2017
pH	Electrometric	6.5 – 8.5
Color	Visual Comparison	10
TDS	Gravimetric	600
Nitrate	Nitrate Electrode	50.00
Turbidity	Nephelometric	5

Also, the measurement of level contamination of the samples was performed using the Multiple Tube Fermentation Technique. The parameters tested were Heterotrophic Plate count to measure the general bacteriological water quality, Total Coliforms to measure the general indication of the sanitary condition of the samples that has been influenced by human or animal waste, and lastly the thermotolerant Fecal Coliforms to indicate if there's the possibility of other bacteria to be present in the water samples.

Statistical tools and Analysis

The researcher used the weighing scale for the environmental impact assessment of the AGUS 1 hydroelectric power plant in the Lanao River in Marawi City. It was limited only to the use of measurement for the impact of AGUS 1 in terms of the environmental aspects.

Table 2: Scoring and Interpretation for the Assessment of Agus-1 Hydro-electric Powerplant

Scale	Mean Score	Interpretation
1	1.00-1.49	Very High Impact (VHI)
2	1.50-2.49	High Impact (HI)
3	2.50-3.49	No Impact (NI)
4	3.50-4.00	Low Impact (LI)
5	4.50-5.00	Very Low Impact (VLI)

The researcher used the following interpretations:

Very High Impact and High Impact: The possible changes and improvements in the environmental management and policies of the Agus Phase were not necessary since it already impacted the life of the resident.

No Impact, Low Impact, and Very Low Impact: Which this study identified as that the Agus Phase I Policies and programs does not significantly benefits or affect the residents of Marawi City and the environment.

The statistical tool that was used to foresee the study is the mean calculated to determine the equivalent impact of each variable. Also, the frequency and percentage were used to assess the respondent's age, gender, educational attainment, civil status, occupation, and years of residency.

3. Results and discussion

3.1. Demographic profile of the respondents

The researcher described the respondent profile in the following: age, sex, civil status, educational attainment, type of occupation, and length of residency. The respondents' demographic profile helped to determine whether the respondents of the survey can provide their insights which are beneficial in developing the environmental policy recommendations of the Agus-1 hydroelectric power plant project. As a summary, the report of the demographic profile with highest percentage are the following: 86% of the respondents of the study were within 18-35 years old; 75% were females, 78% were single, 57% were high school graduates, 78.5% have no jobs, and 71.5% resided for 1 to 10 years in their area. In general, one can observe that many of the respondents of the study were the residents who belong to the lower class of the population, since many of the respondents were unemployed and did not obtained a college degree.

However, it should not be inferred that since majority of the participating respondents do not have occupation, the findings of the study should be treated null. In the study of Young (2011), he explained that individual civic engagement choices are vital to understanding political activity and Policy-making. According to Hansel and Metillo (2016), typically, those with lower educational attainment achieve a lower income, but different outlets for civic engagement exist for people of different income levels. These people may also be less likely to be involved in political or government-based groups, but more likely to participate in a civic engagements such as churches or relief efforts. Young (2021) added, that without the ability to involve civic engagement on the individual level, policy makers are almost certain to miss critical component of the decision-making process by making assumptions about a silent constituency.

3.2. Environmental sustainability

The tabulated data from the Survey Questionnaire is presented first, followed by the discourse Units from the Focus Group Discussion together with the supplementing inferences based on the document reviews. Also, information gathered from the results of the water quality assessment is presented as well, in addition to the mentioned presentations. After the findings of the study with respect to the different variables are presented, the developed policy guidelines is presented.

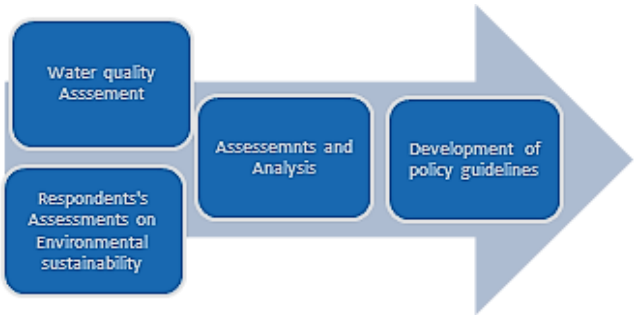

Figure 6: Data Interpretation Outline

Environmental sustainability entails interacting responsibly with the planet to preserve natural resources and avoid jeopardizing future generations' ability to meet their needs. According to the United Nations (UN) World Commission on Environment and Development 2020, environmental sustainability means acting in a way that ensure future generations have the natural resources they need to live a life that is equal to, if not better than, current generations. (Evans, 2020).

Table 3: Environmental Sustainability Assessment of Agus-1 Hydroelectric Plan

Environmental Sustainability	Weighted Mean	Qualitative description
The Marawi City Municipality and the National Power Corporation (NPC) educate other people and me about the potential consequences of using the Agus Phase I hydroelectric power project.	3.2	NO IMPACT
Hydroelectric power plant Agust I developed environmental excellence and community connections that create economic opportunities and improve the ecosystem.	3.0	NO IMPACT
LGU designed and constructed fish ladders.	3.5	LOW IMPACT
Each Barangay has a program to protect the river and different water bodies.	3.7	LOW IMPACT
Management of Hydroelectric power plant Agust I ensures the project does not adversely affect the resident.	3.0	NO IMPACT
Engineered landfills consolidate and segregate potential soil contaminants.	3.1	NO IMPACT

Establish road access restrictions at levels to limit overexploitation of fish and wildlife and non-renewable resources or to optimize permissible access levels	3.0	NO IMPACT
Local government Protect areas with important landscape features	2.9	NO IMPACT
Local government unit implements Revegetation programs (including monitoring and maintenance): conduct fertilizing, seeding, hydroseeding, sodding, and plant tree seedlings and other propagules, either on-site or in compensation elsewhere.	2.9	NO IMPACT
Design measures (site selection) help to keep contaminants away from watercourses (e.g., refueling sites, landfills, berms, sewage tile drains, etc.) - Design measures to limit discharges of pollutants (drip-trays; refueling practices; transformer and sump configurations, etc.)	3.0	NO IMPACT
Total weighted mean	**3.0**	**NO IMPACT**

The overall assessment is that in terms of the environmental programs, policies and regulations developed by the Local officials and the management of Agus 1, the residents could not observe a significant impact of these policies. Based on the number of respondents who answered the survey, there is a consistent trend of those who rated No Impact to Low Impact for all the sustainability indicators mentioned above. This suggests that the Local officials and the management of Agus 1 should improve their policies they implemented in the preservation of the environment around the lake. This finding is supported by the FGD interview from which Participant, wherein when asked about any projects which help protect the lanao lake and its different electrical resources, water resources and land resources or landscapes, the participant stated that *"None, as far as my knowledge is concerned."*

The results inferred that the mandated agencies were ineffective as far as respondents are concern in protecting the areas with important landscapes near the Agus -1 and the programs for re-vegetation, and conducting fertilizing, seeding and plant tree seedling around the hydropower were not sufficient to keep the preservation of forest around the plant. Also, majority of the respondents were doubtful on the management of the National Power Corporation and other agencies in protecting the lake from external contaminants and harmful water pollutants. In addition, they were not satisfied with the measure of the mandated agencies in constructing fish ladders if there's any to facilitate the natural migration of the fishes and other inhabitants in the lake. Thus, since the majority of the respondents were unaware of the Agus 1 phase 1 power plant's programs for the environment, the researcher inferred that the management has a weak regulatory mechanism and poor institutional capacities to implement mandates and policies in protecting lake lanao and the environment. This claim was supported by the study of Naga (2011) where he stated that there was a confusing laws and neglecting of duty form mandated agencies of hydropower dams in Lake lanao that led to the destruction of watershed and pollution of the lake lanao. It indicated that the management lacks tangible programs that make the residents aware of their objectives and plans in the area. In fact, in the FGD, all of the participants declared that they have never been invited to any regular monitoring of the Agus 1, which involves them as consumer, to assess its safety for domestic use and the life of the residences. Participant 1 strongly stated that:

"...I have never been involved in the monitoring for the assessment of its safety for domestic use and life of the residences."

3.3. Agus-1 reservoir's lanao lake water quality analysis

Based on the test results for Micro-Biological Analysis of the three samples, the Heterotrophic count bacteria of the Lake Lanao was 92 which shows a passing rate on Philippine National Standard for Drinking Water for heterotrophic bacteria level. However, it is interesting to note that sample 2 garners the highest heterotrophic plate count because of the location of the sampling collection. In fact, sample 2 was collected from upstream part near of the Agus 1 hydropower plant, while sample 1 is about 200 meter from sample 2, then sample 3 is the farthest location of the water sample collections. This infer that there is an emerging danger of contacting increasing amounts of heterotrophs with regards to the water location samples.

While in terms of Total Coliforms MPN 100ml, Table III shows a result of greater than 8.0 (>8.0), meaning there is a presence of coliforms in the lake. Based on the World Health Organization standard for drinking water, "the recommended maximum acceptable concentration for the overall fecal coliforms must be a complete absence (zero) of detectable organism per 100 ml of water sample analyzes or no more than one of ten analytical units of water sample should have an MPN value of <2.2 MPN/100 ml water". In the assessment, the sample did not meet the criteria and was inferred that there is a bad bacteriological quality of the lake water and a possible contamination and risk of waterborne disease.

The thermotolerant coliforms MPN/100 ml were greater than 0.9 (>0.9), indicating that the water in Lake Lanao is

not safe for human consumption. The results revealed that there was a presence of fecal coliforms, a type of bacteria found mainly in animal digestive feces and tracts, and one of the specific indicators of fecal contamination of water in Lake Lanao. In addition, the lake also finds a presence of a significant number of coliforms which are harmful bacteria that can result in diseases in humans.

Table 5 shows that the physical and chemical characteristics of Lake Lanao on the visual comparison-chloroplatinate, Lake Lanao fall in within the standard of National Standard for Drinking Water in the Philippines. In terms of turbidity, the result showed a passing remark based on the standard of Philippine National Standards for Drinking Water (PNSDW). In terms of chemical characteristic of Lake Lanao, the table shows that pH value at 25.0 0C analyzed thru the 4500-H+Electrometric passed. Lastly, the nitrate and the total dissolve solids obtained a passed remark. With this, the Lake Lanao passed the standards of the PNSDW for both physical and chemical characteristics.

However, from the table above it can be noted that there is a gradual increase of pH level. In the NPC (2020) report of water quality assessment, it shows that pH level of lake lanao near Agus-1 was 6.5 in the 3Q of 2019 and lower pH levels in 2Q of 2020. However, the pH level of 7.6 in the year 2022 shows a sudden change of pH levels in Lake Lanao. This inferred the correlation of the presence of total coliforms and the increase in the pH level in Lake lanao in the year 2022, a claim that was proven by the study of Boone and Xun (1987) supported by the study of Nzung'a Sila (2019) which they stated that an increase of pH value greater than 7.0 is vital for growth and reproduction for the majority of pathogenic bacteria such coliform bacteria specifically E-coli. With this result, although it can be identified that the water of Lake Lanao is still clear and the chemical substances is still categorized in a low score, however since the water of Lake Lanao were also tested in microbiological analysis and failed even if it passed in the physical and chemical characteristics limit, the lake is still not safe due to the existence of the coliform and other bacterial substances that are harmful for human.

Due to the lack of wastewater management, programs and measures of the mandated agencies in Marawi City, pollutants such as human waste, soil pollutions, and animal carcasses greatly contributed to the increased count of coliform bacteria in the Lake Lanao. The study results emphasizes that Agus-1 Hydroelectric Plant had greatly contributed the bacterial content of Lake lanao. The researcher concluded that the Local Government Unit, the National Power Corporation, and other LGUs have a low efficiency in implementing their rules, regulations and policies in protecting Lake Lanao. Based on the results of the water quality, it shows that the National Power Corporation must be more strict and evaluative to protect the Lake Lanao, and to fulfill the moral obligations and legal duty in the environmental laws as the authority in charge of Agus 1 hydroelectric Plant.

Table 4: Micro-Biological Assessment of Agus-1 Reservoir's Lanao Lake

Sample	Heterotrophic Plate Count CFU/ML	Total Coliforms MPN 100ml	Thermotolerant (Fecal) coliforms MPN/100ml	Remarks
Scale	<500	<1.1	<1.1	
Sample 1	100	>8.0	<1.1	FAILED
Sample 2	125	>8.0	>8.0	FAILED
Sample 3	50	>8.0	>8.0	FAILED
AVE. VALUE	92	>8.0	>0.9	FAILED

Table 5: Physical-Chemical Assessment of Agus-1 Reservoir's Lanao Lake

Sample	pH	Color	TDS	Nitrate	Turbidity	Remarks
Sample 1	7.8	5	73	0.44	0.75	PASSED
Sample 2	7.4	4	70	0.10	0.2	PASSED
Sample 3	7.6	3	50	0.10	0.2	PASSED
AVE.	7.6	4	64	0.21	0.38	PASSED

3.4. Assessments

Agus -1 Hydroelectric Power Plant needed to attain and maintain an orderly balance between socio-economic growth and environmental protection. Also, according to the Philippine Clean Water Act of 2004, the National Power Corporation, DENR and other agencies is mandated to protect the Agus Pulangi River and Lanao River as a right of the resident, in order to have a balanced and healthful ecology that is in accordance with the rhythm and harmony of nature. The state shall promote and protect the global environment by attaining sustainable development, while recognizing the primary responsibility of local government units to deal with environmental problems. Hence, the Agus Phase I Power Plant policy implementation needs to be improved and developed.

The followings were the findings of the study that the mandated agencies were obliged to address for the

sustainability of the Agus-1 Hydroelectric Plant and in compliance with the Philippine Clean Water act of 2004 and Presidential Decree 1586 for Environmental Compliance Certificate:

Solid waste management plan issue: There was generated solid wastes from the facility and the workers of the National Power Corporations assigned in Agus -1 Hydroelectric Plants and soil contamination had occurred due to accidental fuel or oil spillage. Also, there had been moderate a soil erosion due to the activities of the powerplant such as replacement and repair of hydromechanical equipments.

Educational awareness: Majority of the respondents have no knowledge or have not experienced any awareness programs of the authorities about the programs, consequences, safety and policies of the establishment of Agus-1 Hydroelectric plant.

Environmental protection Protection and Preservation: Based on the document and literature reviews and Respondent's perception, the National Power Corporation, DENR, Local Government and other agencies have a weak inter-sectoral collaborations and measures with regards to the protection and preservation of the environment specifically near the Agus-1 Hydroelectric Plants. This study found out that there was weak revegetation and plant seedling programs, implementation of fish ladders, design measures to prevent the contaminants away from Lake Lanao, Engineered landfill for potential contaminant segregation, and regulatory to protect Lake Lanao from over exploitation.

Watershed Management: As found in this study, there's an evident deterioration of water quality of Lake Lanao specifically near Agus-1 hydroelectric Plant. Also, there's a lack of regulation with regards to water contaminants and pollutant released from the city, industries, erosions and agricultural run-off.

3.5. Policy measures for the sustainability of Agus-1 hydroelectric plant

On the basis of the assessments and findings of this study, it was found out that the mandated agencies concerned in upholding environmental stewardship did not effectively meet the standards of the Philippine Clean Water Act of 2004 and Presidential Decree 1586: Environmental Compliance Certificate upon the operation of Agus phase I. It is therefore imperative for this study to develop a possible policy measures which the authorities can apply in regard to the operation of the Agus Phase I. It is also necessary to recommend potential programs that they can execute for the purpose of meeting the essential requirements and the improvement of the lives of the residents as well as the protection of the environment.

Thus, In order to promote national security and public interest with the active participation of the stakeholders in the watershed areas and in the host communities, and order to prevent environmental pollution and enhance the conservation, development and maximum utilization of natural resources in NPC operations, this study proposed the developed policy measures for the environmental sustainability of the Agus-1 Hydroelectric Power plant:

Environmental Excellency

Plan forecasting activities that include a detailed documentation of the evaluation of possible effects and consequences using consultation with potentially affected communities. Make use of policy instrument stated in Presidential Decree 1586 (Establishing an environmental impact statement system) and Government programs to discourage unsustainable behavior, and to provide incentives for the protection of ecosystems and forestry practices.

Coordinate and strengthen the role of Palao (Mountain) rangers that was recently mandated and authorized by the BARMM government to protect the environment, ecosystems, land, and Lake Lanao.

Team with the LGUs and the monitoring team of NPC to promote a regulation in the fishing industry with management tools that internalize the social and environmental costs or harms of fishing in the lake.

Develop fisheries strategies and programs to help achieve sustainable fisheries and marine conservation with the explicit goal to reduce fishing harm.

Set maximum viable parameters for water consumption and water pollution in the lake to ensure the appropriate balance between water, people and nature. Such parameters should provide awareness and information on the lake basins' accessibility and pollution integration capability.

Enact an inclusive screening process that involves thorough scoping of issues using seminars and participatory stakeholder approaches so that environmental assessments are targeted to address the substantive issues and consequences of the Agus-1 power plant.

Watershed Management

Have a regular conduct of a water quality assessment of Lake Lanao and report the progress and current situation of the Lake in different Barangays near the Agus Phase 1 power plant.

Impose fines/charges on residents who are caught throwing garbage and other toxic materials into the Lake. The Agus phase's management must hire an environmental keeper to ensure that the lake is protected from various activities that residents and businesses carry out in the area.

Plan opportunities to work with communities through awareness/seminars, and with appropriate government agencies, to improve waste management practices and minimize discharge into the lake.

Implement educative actions to avoid or minimize the release of identified contaminants into Lake Lanao.

It is then through these developed measures, that the authorities could maintain its mission and not imperil its business, stakeholders, consumers, workers and the entire habitat as a whole.

4. Conclusion

Evidently, the results inferred that the Agus 1 power plant management has poor transfer of information among the residents. Most of the respondents were unaware of the Agus 1 Phase1's policies and the management regulations.

Majority of the residents living near the dam did not experience attending any seminars on the operation of Agus phase 1 hosted by the local government unit or the national power corporation. It demonstrates that the policies implemented by the NPC and Marawi City's LGU were inefficient, and the impact of the operation of the Agus phase 1 power plant was minimal.

Based on the findings, the local government units of Marawi city and National Power Corporation shall conduct projects and ordinances that will help improve the water quality of Lake Lanao and enhance the operation of Agus Phase 1 Power Plant. In addition, implementing water policy provisions and environmental codes also need to be strictly enforced in the area to decrease the number of coliforms in the lake, which will ensure the health safety of the residents. Also, the Local government unit of Marawi city must exert effort to conduct a seminar in the different barangays, in order to educate the resident and barangay leaders on the importance of Lake Lanao and Agus Phase 1 Power Plant in the community and to improve their participation/ involvement in maintaining their environment. The National Power Corporation is encouraged to provide baseline data and information for the present situation of the Agus Phase 1 Power Plant to inform and update the residents. In addition, this study also recommended that the National Power Corporation and the local government unit must enhance the Agus 1 Power Plant Operation to develop environmental excellence and improve the ecosystem.

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