A Cost-effective Fish Pond Monitoring and Warning System Using Thermal Probe

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***Abstract* - "Fishes, shrimps, crabs, eels adrift along Pampanga River" this is just one of the headlines about fish kill here in our country. This phenomenon, commonly experienced by fish farmer pursuing fish farming in freshwater and coastal areas, was suddenly manifested at an unexpected scale that it leaves us questioning what went wrong and why it happened. In this study, the proponents developed a system that will continuously monitor the dissolved oxygen level through the use of a thermal probe, to assess as whether the fish pond is still safe or not for the aquatic lives in it. An equation used to approximate oxygen level using temperature was obtained. Warning system was also produces as part of the system to notify fish farmer of the sloping downward quality of the fish pond water, and another warning when the level of the dissolved oxygen in the fish pond is already reaching the threshold. Validation of the system is done by comparing the response of the oxygen meter, which is too expensive, and the proposed system using thermal probe.**

Keywords - ***Aquatic Resources, Dissolved Oxygen, Monitoring, Fish Kill***

I. INTRODUCTION AND BACKGROUND

In 2014, the Philippines ranked 8th among the top fish producing countries in the world with its total production of 4.7 million metric tons of fish, crustaceans, mollusks, and aquatic plants (including seaweeds). The production constitutes 2.4% of the total world production of 195 million metric tons as per Food and Agriculture Organization of United Nations. Hence, this kind of phenomenon has a big impact not just for our fish farmers but also to the whole country, with reference to our Gross Development Product annually.

Way back 2011, the country was besieged by a string of fish kill events that not only affected the "traditional" coastal finfish growing areas in the country (e.g., Pangasinan) but was also happening in freshwater lakes (i.e., Taal Lake) at a scale that worried people from all sectors. In line with this, a fish kill forum was held at UP Diliman as attended by different kinds of people from stockholders up to the fish farmer themselves. The recommendations from the fish kill forum were: 1) a national fish kill quick response is needed; 2) an effective monitoring and surveillance system has to be established; 3) accountability and compliance is key; 4) a two-stage licensing system for mariculture activities in order to provide checks and balances is important; 5) LGUs need to review and further strengthen existing sanctions and monitoring mechanisms; 6) empowerment and education are essential; 7) fishers and stakeholders must be aware of and apply only the proper technologies and practices in mariculture; 8) a comprehensive national framework on sustainable aquaculture must be put in place; and 9) regular forums on mariculture must be conducted for the benefit of all stakeholders. Therefore, the proponents would like to address this problem with the application of the second recommendation: "an effective monitoring and surveillance system to be established" with their thesis entitled: "AquaMode: Aquatic Resources Monitoring Device."

II. MONITORING AND WARNING SYSTEM

A. Significance

The findings of this study will redound to the benefit of the country's fish farmers considering that one of the main natural resources of the Philippines is aquatic resources. The fisheries and aquaculture industry employed an estimate of 1.5 million people in 2010 nationwide, the fishing industry contributes an estimate of 1.8% to the country's Gross Domestic Product and in 2014, the foreign trade performance of fish industry gave a net surplus of 954 million dollars with a total export value of 1,724 million US dollars and import value of 320 million US dollars. These factors determine the essence of the fishing industry in our country, that it helps in maintaining the economy that is why fish kill incidents should be a major concern of the country.

The significance of this study is focused and designed to help fish farmers prevent loss of income due to unexpected fish kill. It is also significant to organizations and government agencies which studies aquatic resources as the system can monitor and provide data needed for the study of fish kill.

B. Limitations

This study was conducted to develop an aquatic resource monitoring device that will provide temporary prevention to fish kill and an audio device and SMS as a near-real-time alarm system for the detection of a consistent decrease in oxygen level, or oxygen depletion. Given that there are numerous causes of fish kill, it is known that oxygen depletion is the primary cause. Thus, this study is limited in the approximation of oxygen depletion through the use of a thermal sensor. Since fish kill occur unexpectedly without a warning, the system in this study provides a real-time update on the behavior of the water quality as to what is safe for the aquatic resources. Moreover, a temporary preventive system is created limited to aeration system to extend the amount of time before the critical level be reached. It will also be used to give fish farmers allowance to do the necessary actions before the level of dissolved oxygen level be fatal to the aquatic resources.

III. RESULTS AND DISCUSSION

A. Correlation between temperature and dissolved oxygen level

It was found in a previous study that temperature and dissolved oxygen level in water has direct linear relationship. This became the guide of the proponents to replace the very expensive oxygen meter with the very cheap thermal sensor.

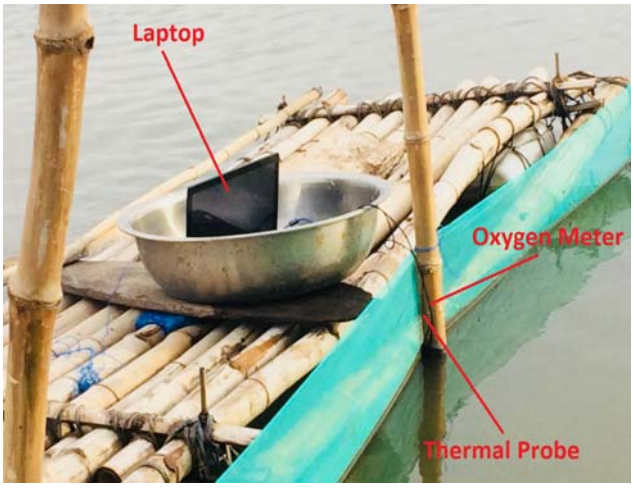

Figure 1. Simultaneous data gathering of temperature and dissolved oxygen

Shown in figure 1 is the during the data gathering procedure in getting raw measurements of temperature and dissolved oxygen simultaneously. This was done to establish relationship between the two parameters and to form an equation that shall approximate oxygen level using the read temperature. After 8 hours of data gathering for 3 days, the strength of association between the temperature and dissolved oxygen (DO) where established and is summarized in the given table below.

TABLE I. CORRELATION BETWEEN DO AND TEMPERATURE

Correlation Coefficient	Relationship	Interpretation
0.7692	Inverse / Indirect Relationship	Highly Correlated

Since in the related literature it was stated that a linear between the two parameters exist, the proponents developed a linear regression. Upon calculation, the resulting regression line is:

$$O = -179.987 + 6.351387 * T$$

where O corresponds to Oxygen level in mg/L and T corresponds to Temperature in degree Celsius.

B. Warning Notification System approching and at threshold level

A notification feature was developed also in this study. This is to give awareness to the fish farmers of the possible danger that the water quality might have. The awareness given is regarding the updated dissolved oxygen level. By this information, the fish farmer can do necessary action towards the situation such as the harvesting some of the fishes in pond before dying to ensure that the dissolved oxygen level will be enough for the remaining fishes in the

pond. Thus, the harvested fishes shall be sold right away to avoid financial losses. Note that in the Philippines, and in other country as well, dead fishes before harvesting are not allowed to be sold in the market.

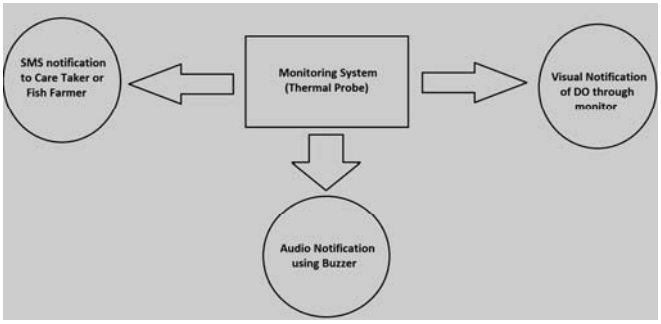

Figure 2. Notification System

The notification system was tested and evaluated if properly working by triggering the system to reach a critical level. The sensors are exposed to an almost boiling water which by property possess very low dissolved oxygen. Upon testing, the result are as follows:

TABLE II. SYSTEM RESPONSE WHEN EXCEEDED THRESHOLD

Time Conducted	11:09:54
Measured Dissolved Oxygen	3.87 mg/L
Approximated Dissolved Oxygen	3.54 mg/L
SMS Notification	Received 11:10:06
Audio Buzzer	Enabled 11:09:58
Monitor (Visual)	Display turn Red (indicating critical issue)

In this study, the threshold was set to 7 mg / L as according the standard set by Department of Science and Technology – Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST – PCAARD). And as being summarized by table above, it can be seen that the device approximates the dissolved oxygen level accurately with minimal percentage of error. Thus, the notification systems give proper information to the user at a reasonable time delay.

C. Temporary Preventive System

Besides of informing the fish farmer on the possible danger that the water quality in real time, the system also creates a mechanism that will help the fish farmer have just enough time to create necessary action. This is by temporarily slowing down the rate at which the dissolved oxygen is depleting. The depletion of dissolved oxygen is inevitable when approaching to "fish kill" but manipulating the rate that this is falling can be done.

In this system, an aeration system is enabled whenever the threshold is reached. A water pump just enough for 30 square meters fish pond is turned on and off by the processor of the system. Shown in the figure below is the algorithm used in enabling the aeration system.

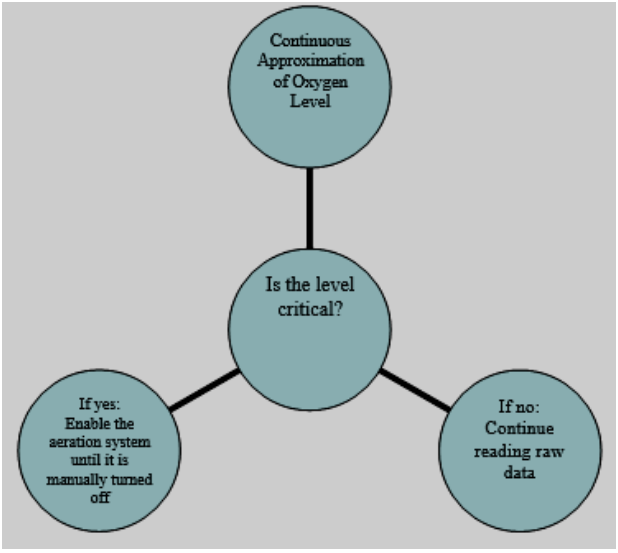

Figure 3. Aeration System Decision Making

Upon the activation of the aeration system, an observation was found regarding the behavior of the water quality in terms of dissolved oxygen count, approximate and true value.

TABLE III
Dissolved Oxygen Before and After Aeration

	Approximate Dissolved Oxygen (mg/L)	**Measured Dissolved Oxygen (mg/L)**
Before Aeration	5.78	6.03
After Aeration	6.12	6.56

It is evident in the table above that the aeration system contributes to the increase of dissolved oxygen level in the fish pond which is a great help in lessening the fatality among the aquatic resources in the said fish pond.

IV. CONCLUSION AND FUTURE WORK

Based on the observations gathered while conducting the study, some conclusion has been made. It can be concluded from the study as a whole that the use of temperature to predict dissolved oxygen level is effective. However, equations of the relation between these two parameters vary with respect to the target environment. This means that for every fish pond, an equation must be obtained prior to the use of the system. This maybe due to the varying property of different water environment such as salinity, acidity, etc.

Another major observation in this study is the indirect relationship between temperature and dissolved oxygen level. From this it was concluded that the system is highly needed at the periods when temperature is high.

Moreover, regarding the notification system, it was noticed that SMS sometimes fail due to poor signal in the area. However, the use of audio alarm plus the real time update visual monitor are efficient alternative during the failure of SMS.

Furthermore, it was observed that the fish farmer took several minutes to harvest fishes in the pond. Therefore, we conclude that the aeration system must continue functioning until it is disabled manually. By this, it will just extend the time before the water in the pond have below threshold dissolved oxygen.

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