# AquaSM: Water Quality Simulation Modeling Tool for Wetlands using Linear Regression

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## CHAPTER I

## 1. INTRODUCTION

This chapter introduces the research project entitled **"AquaSM: Water Quality Simulation Modeling Tool for Wetlands using Linear Regression"**. This chapter includes the project context, purpose and description, objective, scope and limitation.

### 1.1 PROJECT CONTEXT

Wetland is an ecosystem surrounded by waters whether permanent or seasonal, natural or man-made. In the Philippines, there are 6 wetlands declared as Ramsar sites namely Olango Island, Naujan Lake National Park, Agusan Marsh Wildlife Sanctuary, Tubbataha Reefs National Marine Park, Puerto Princesa Subterranean River National Park, and lastly the Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA). Ramsar is a convention on wetlands that provides national action and international cooperation for the conservation, prevention and wise use of wetland resources.

Wetlands are being conserved because of its great roles in the environment like water purification, flood control, and shoreline stability. In the study conducted by (Ma et al. 2012) about wetlands in China, they observed that wetland ecosystem is one the most productive and the most diverse habitats all over the world because wetlands not only provide water resources, aquatic products for human, but also provide ecological function such as improving climate, cleaning water quality, and playing role in maintaining ecological balance. Wetlands have been used as a water source for irrigation, reclaimed for agricultural production, used as fish habitat, and exploited for aquaculture and urban development (Ma, Zhang, Zhang, Zhou, & Mao, 2012). Thus, because of these, the scientific and lay community have been encouraged to promote conservation and protection of these very important ecosystems.

In order to help conserve and protect these ecosystems, the proponents develop a simulation modeling tool that can help analyze the water quality around the LPPCHEA particularly the two river system that ends in the said coastal environment, i.e., Parañaque and Las Piñas rivers. One of the factors affecting the water quality comes from these two rivers especially from domestic and industrial communities along the riverbanks. These inhabitants along the river may be the sources of oil/grease and heavy metals that pollute the rivers of Parañaque and Las Piñas that may eventually contaminate the coastal water of LPPCHEA. The simulation model makes use of the data gathered by the LPPCHEA management under the Department of Environment and Natural Resources (DENR). This simulation modeling tool offers an in-silico-based alternative solution in drafting policies and design of technologies for the conservation and preservation of LPPCHEA and possibly, other Philippine wetlands.

### 1.2 PURPOSE AND DESCRIPTION

Philippines wetlands are also important wintering grounds for migratory birds from different parts of Asia-Pacific region. Due to their importance to migratory waterfowl and endemic Philippine species, six of the country's wetlands areas have been declared Wetlands of International Importance under the RAMSAR convention and receive protection under the treaty. Since Philippines is an archipelago and endowed with thousands of square miles of wetlands and abound with mangrove swamps, fishponds, rivers and estuaries, marshes, swamps and rice paddies, these bodies of fresh and brackish water provide irreplaceable habitats to numerous species of wildlife and are of critical importance to waterfowl. These ecological and economic values of wetlands must be conserved and protected, thus this simulation modeling tool warrants development.

This study aims to develop a simulation modeling tool which would aid different stakeholders such as the Department of Environment and Natural Resources (DENR), environmental scientists, non-government organizations and other agencies in crafting policies and efforts in the conservation and protection of wetlands like Las Piñas-Parañaque Critical Habitat and Ecotourism Area

(LPPCHEA). This study focuses on the Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA) since the site is located in an urban area. The effects of the urban settlers is one critical factor on the dangers it can bring to the LPPCHEA area.

## 1.3 OBJECTIVES

The objective of this study is to provide a simulation modeling tool to predict the level of acidity and alkalinity (pH), Dissolved Oxygen (mg/L), Biological Oxygen Demand (mg/L), Total Suspended Solids (mg/L), Oil and Grease (mg/L), Chromium (mg/L), Cadmium (mg/L), Mercury (mg/L), Lead (mg/L) and Total Coliform (MPN/100L) in water particularly the Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA). This simulation tool can aid different organizations in conserving and protecting the LPPCHEA wetlands. Once the simulation tool become successful in monitoring different factors affecting LPPCHEA area, it can be applied to other coastal areas in the country, since the Philippines is an archipelago and is surrounded by an estimated area of 36,289 km of coastline. This tool allows users to input experimental data used for the predictive analysis. The results made by this tool can be used as basis for the decision that can be made in that area.

## 1.4 SCOPE AND LIMITATION

The capability of this simulation modeling tool is to help the user to see the results of the factors that are affecting the LPPCHEA wetland. This tool provides predictive analysis map of different variables used by LPPCHEA in monitoring wetlands. It also illustrates graphs that can be used for presentations or documentations. The data encoded by the LPPCHEA based sampling results on the area help in decision making for its protection and conservation.

The limitation of this simulation modeling tool relies on the data in getting the required results. Also this system does not consider changes in the weather and other outside factor that can affect the result of the simulated factors.

# CHAPTER II

# 2. RELATED LITERATURE

The objective of this chapter is to give better indulgence on the project, which facilitate the users, students to be aware of the whole concept of this project. Related literatures can assist the researchers to know more about the topic.

## 2.1 Wetland

The Ramsar Convention defines wetland as “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters.” This definition also covers the inland and coastal wetlands. The study of World Wide Fund for Nature (WWF) the Economic Values of the World’s Wetland (2014) that wetlands are important ecosystem that occupies about 6% of the world lands surface. There are three classification of wetlands the marine or coastal, inland, and man-made wetlands. The function of wetland in ecosystem is that it regulate ecological processes that commit to a healthy environment. Like recycling of nutrients and human waste and climate regulation. It also provides habitat for animal.

## 2.2 Protection and Conservation of Wetlands

Because there are a lot of values and benefits wetlands can give to a country, many organizations are participating in the protection and conservation of wetlands. Different projects were instituted by different countries to make this happen.

In the study of Dr. Tonie O. Balangue the Final Report Updating the Vulnerability of the Las Piñas – Paranaque Critical Habitat and Ecotourism Area (2014) that in the Philippines, the **Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA)** is the first critical habitat declared in the Philippines under Proclamation No. 1412. The proclamation is needed for the protection and conservation of endangered local and migrant birds and its wetland status. LPPCHEA also attracts wild bird enthusiast and eco-tourists because of the number of migratory and local wild bird species that will be found in the area. It also faces a lot of threats to maintain its stability as a place for wild animals, because of the quarrying of sand and gravel, harvesting of mangroves, inappropriate garbage disposal and also squatting. That is why the objective of the LPPCHEA is to study the vulnerabilities that affect the sustainability of the area for the avian habitat. Also, LPPCHEA’s objective to identify and track the threats that affects the water quality of the area. This is to provide policies that will improve the management of the LPPCHEA as a critical wildlife habitat and ecotourism area.

The **Office of Environment and Heritage (OEH)** (2015) is engaged with the communities and other agencies to protect wetlands across New South Wales (NSW). The OEH has invested considerable wetland maintenance programs including the

Rivers Environmental Restoration Program, Riverbank and the Wetland Recovery Program. OEH manages the distribution of environmental water to benefit rivers and wetlands.

## 2.3 SIMULATION MODELING

Simulation Modeling is a method of solving problems, in a way that it replaces the actual system by an object that act as the real system and its behavior. Simulation modeling is used in experiment or testing if the real system is impossible to use or it will take time to know the results. The advantage in using this method is that it allows the experiment without disruptions to existing system. Also the revelation of error or problems will be seen in the simulation so it can be avoided in applying to the original system. The speed of simulating experiments is one of the great advantages of simulation modeling because results can be seen instantly rather than testing it to the original system.

But there are also limitations or disadvantages of using simulation modeling. It is time consuming in gathering the needed data in order for the simulation to work properly or for the results to be accurate. Simulation modeling is always based on data. It cannot function independently.

## 2.4 SIMULATION MODELING SOFTWARE

There have been many simulations modeling software being implemented in different environmental causes. Some of these simulations are described in succeeding paragraphs.

The study of Moeseneder et al. (2014), the **Simulation Interface Designed for Improved User Interaction and Learning in Water Quality Modeling Software** a simulation software that supports management decisions is configured and run by experienced scientists. This software presents management strategy evaluation capabilities. And it enables users to learn about water quality management. The MSE tool is not intended to provide actual real-world advice but provides a proving ground for users to interactively design strategies, analyze the intricacy inherent to water quality management using a simple yet effective user interface.

This water quality modeling software and the AquaSM are both simulation tool that will be used by experts in understanding the water quality. The difference of the two is that the Water Quality Simulation Modeling Tool for Wetlands Using Linear Regression will be simulating variables to identify the level of the water qualities vulnerability.

Another simulation modeling software developed by Weber et al. (2013), is the Water Quality Analysis Simulation Program (WASP7). WASP7 is a simulation model that helps the user to illustrate and predict the response of the water quality to manmade pollution and to natural phenomena. WASP7 is one of the most used simulation model for water quality in the United States.

The WASP7 and AquaSM are both system that simulate factors affecting the water quality that are caused by human. The difference between the two is that WASP7 predict the response of the pollution that is caused by human to a natural phenomenon that could happen.

# CHAPTER III

# 3. TECHNICAL BACKGROUND

This chapter discusses the relevant technical aspects of the research project which includes the software to be used in the development.

## 3.1 Microsoft Visual Studio

Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is a collection of developer tools and services to help develop computer program. It is used for building ASP.NET Web applications, XML Web services, desktop applications and mobile applications.

The researchers used Microsoft Visual Studio because they develop the application with C#. The researchers have also used this for years which give them enough experience on how to use this.

## 3.2 C# Programming Language

C# is an object-oriented programming from Microsoft which is integrated in Microsoft Visual Studio. It aims to combine the computing prowess of C++ with the ease of Visual Basic. C# uses the functionality of .NET framework which provides access to technologies that simplify the development of applications.

The researchers used C# which provides controls which has properties that is used for the UI and events that is used for the process of the application. C# is used for developing the web application.

## 3.3 MySQL

MySQL is an open source database management system which uses structured query language (SQL). SQL is a language for adding, editing, accessing, and managing contents in a database. MySQL is mostly used as a database for web applications.

The researchers used MySQL for the database of all the data that is provided by the LPPCHEA. MySQL is the database to be used for web applications.

### 3.4 Adobe Photoshop

Adobe Photoshop is an image creation and editing tool created by Adobe. It is used for the manipulation of graphics and enhancement of the interface design of the application.

The researchers used Adobe Photoshop to create graphics integrated on this system.

## CHAPTER IV

## 4. METHODOLOGY

This chapter discuss the design and methodology of the project. This chapter includes the methodology which involves processes in developing the AquaSM: Water Quality Simulation Modeling Tool for Wetlands Using Linear Regression. Specific flow and design are discussed in chapter to attain the main purpose and objectives of the project.

### 4.1 SYSTEM METHODOLOGY

The researchers have chosen prototyping methodology to develop the system. The type of prototype that the proponents chose is the evolutionary prototype, where the initial prototype became the final system. It is done through iterative incorporation of user feedbacks. Prototyping methodology promotes requirement gathering, quick design, building prototype, customer evaluation, refining project, and engineering product. And because of these, the researchers will have a process in developing the system and completing it.

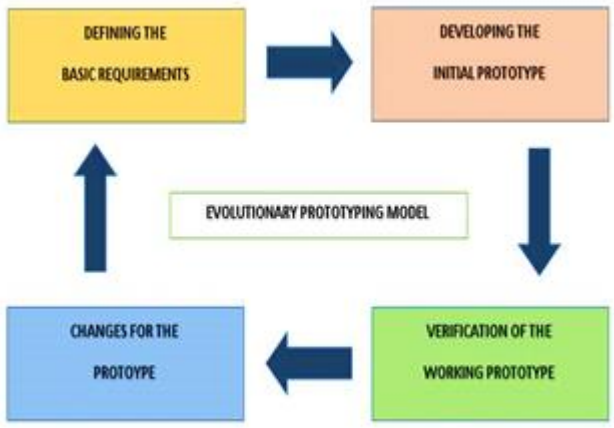


*Figure 4.1 Evolutionary Prototype Cycle*

The prototyping methodology allows the users to be actively involved and get a better understanding in the development of the simulation modeling tool. It also leads the proponents to have a quicker user feedback that leads to a better solution. Prototype methodology is used to easily detect errors and missing functionality of the system. It is also used to reduce the risk in developing the system, early issues where identified in the development and make it easier to the proponents to develop solutions to the issues. The lifecycle includes Defining the Basic Requirements, Developing the Initial Prototype, Verification of the Working Prototype, and Changes for the Prototype.

Defining Basic Requirements this is where the data and information are gathered, also this is where the basic things about the system should also be identified. Developing the Initial Prototype is where basic requirements about the system are provided. Verification of the Working Prototype is where surveys and experimentations on the prototype are done by the users of the system this is also where users cater their suggestions and recommendations on the system for the better change. Changes for the Prototype is where suggestions and recommendations on the system that are made by users are being implemented.

#### 4.1.1 Defining Basic Requirements

After the verification, the user added requirements for the proponents to integrate in the system. The requirements to be included are the excel file format for saving and printing the reports and the graphical view of the reports must have a header that contains parameter name and their standard values. Plus the system must have expandable space for easy viewing of reports and heavy loaded tables. In addition the proponents added a registration for root account and database creation for fresh installation of the system.

### 4.1.2 Developing the Prototype

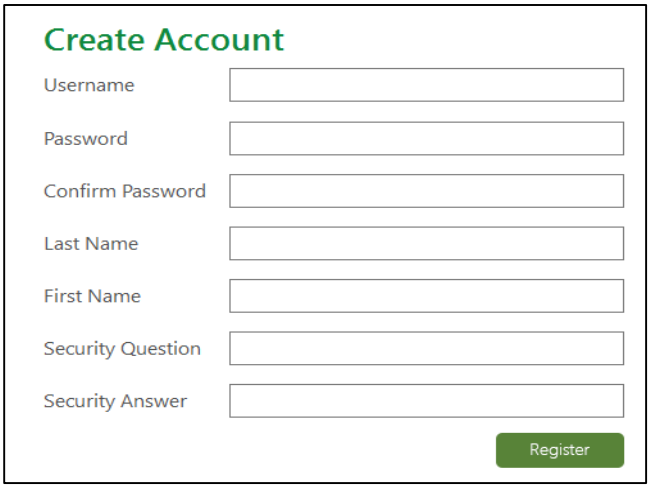


*Figure 4.1 Registration for Root Account*

The proponents added a registration form for the user's first account after installation of the system. The account created will be the root admin account of the whole system. This account is the only one that can allow other user to sign up for the system. The system will create the database automatically if it doesn't exist.

### 4.1.3 Verification of the Working Prototype

The proponents contacted the users to schedule a meeting. On the meeting, the proponents showed the changes that the users recommended on the previous meeting. The users were satisfied but they still suggested to add a few things. The users discussed that the proponents need to add the tide schedule, a month filter for the graph to observe the values on a certain month but different year, and the ability to compare graphs. Other than that, the users are glad and said that the system is already finished even without the changes.

### 4.1.4 Changes for the Prototype

After verifying the prototype with the users, the proponents started to work on the recommendations given by the users.

## CHAPTER V

## 5. RESULT AND DISCUSSIONS

This chapter discusses the result, analysis of the survey, tabulations and survey done by the researchers in determining functionality, usability, reliability, performance and supportability of AquaSM: Water Quality Simulation Modeling Tool in Wetlands using Linear Regression.

### Survey Results

The researchers demonstrate the features and let the users manipulate the system. After the users observed and used the system, the researchers presented questionnaires for the evaluation on the system. Based on the criteria written on the questionnaire and by using the statistical treatment data, the respondents were able to assess the system.

### Profile of the Respondents

The researchers conducted a survey to 10 respondents in order to determine the acceptability of the system. The chosen respondents of the study were the Department of Environment and Natural Resources – NCR (DENR-NCR) employees. Shown in Table 5.1 was the percentage distribution of the respondents.

| Respondents | Frequency | Percentage |
|---|---|---|
| DENR-NCR Employees | 10 | 100% |
| **Total** | 10 | 100% |

*Table 5.1 Users' Percentage Distribution Table*

### Perception of the Respondents

The developed research projects entitled "AquaSM: Water Quality Simulation Modeling Tool in Wetlands using Linear Regression" was measured based on its functionality, usability, reliability, performance and supportability. In order to know the equivalent qualitative interpretation, the proponents used the Likert Scale as a basis for the range of ratings. This was shown in Table 5.2.

| Scale | Range of Mean | Interpretation |
|---|---|---|
| 4 | 3.26-4.00 | Highly Acceptable |
| 3 | 2.51-3.25 | Acceptable |
| 2 | 1.76-2.50 | Fairly Acceptable |
| 1 | 1.00-1.75 | Not Acceptable |

*Table 5.2 Likert Scale*

## Tabulation of Results

After the respondents evaluated the system, the proponents computed for the mean of each criterion. It determined the level of acceptability of the system for its users. The following table shows the summary of ratings based on the criteria given by the proponents.

| Criteria | Mean | Interpretation |
|---|---|---|
| Functionality | 3.9 | Highly Acceptable |
| Usability | 3.93 | Highly Acceptable |
| Reliability | 3.87 | Highly Acceptable |
| Performance | 3.97 | Highly Acceptable |
| Supportability | 3.87 | Highly Acceptable |
| **Overall Mean** | **3.91** | **Highly Acceptable** |

*Table 5.3 Overall Survey Result of AquaSM: Water Quality Simulation Modeling Tool in Wetlands using Linear Regression*

The overall result of the AquaSM: Water Quality Simulation Modeling Tool in Wetlands using Linear Regression was shown in Table 5.3. The system got 3.91 for the overall mean and interpreted as Highly Acceptable system. It shows that the software meets the objectives for it was intended to be used for.

# CHAPTER VI

# CONCLUSION AND RECOMMENDATION

## Conclusion

The AquaSM: Water Quality Simulation Modeling Tool for Wetlands using Linear Regression got a highly acceptable result with the mean of 3.91 from the survey conducted by the proponents. This means that the system achieved its objectives in providing a simulation modeling tool to predict the level of parameters in the water. The researchers concluded that the AquaSM: Water Quality Simulation Modeling Tool for Wetlands using Linear Regression will be a big help in providing decisions for the protection and conservation of wetlands.

## Recommendation

The researchers recommend further study of the system to improve the accuracy of the prediction of water qualities. And be able to consider the changes in weather and other outside factor that can affect the result.