I. INTRODUCTION

A. Background of the Study

Persistent organic pollutants (POP's) are a class of chemicals that persists in the environment. They are capable of long-range transport, are able to bioaccumulate in human and animal tissue, and have significant impacts on human health and the environment. They include such substances as dioxin, Polychlorinated biphenyls, hexachlorobenzene, brominated flame-retardants or *tributyltin* (TBT) [1]. POP's released to the environment can travel through air and water to regions far distant from their original source.

Common to these toxic organic pollutants is persistence. Many persistent organic pollutants (POP's) are chlorinated compounds [2]. With the evidence of long-range transport of these substances to regions where they have never been used or produced and the consequent threats they pose to the environment of the whole globe, the international community has now, at several occasions called for urgent global actions to reduce and eliminate releases of these chemicals [3]. One international treaty an among countries is the Stockholm Convention. It is aimed at protecting human health and the environment from POP's.

Locally, the Department of Environment and Natural Resources – Environmental Management Bureau (DENR-EMB) is undertaking inventory of persistent organic pollutants as part of the implementation of the Stockholm Convention. Building upon the results of the POP's enabling activities, the National Implementation Plan was prepared taking into consideration the needs of the Philippines in addressing POP's issues in the country. It is formulated taking due account of the overall aims of sustainable development in the sense of socially, economically and environmentally appropriate policies and actions [4].

The DENR- EMB set up the POP's Project Management Office tasked primarily to establish a coordinating mechanism for the development of the National Implementation Plan. As a result, an Inter-Consultative Committee was formed. The POP's Inter-Consultative Committee members are representatives from various government agencies and non government agencies who have direct and indirect involvement in the management and control of chemicals in the Philippines [5].

The group has set up different monitoring stations within Metro Manila to monitor pollutants. Different teams are responsible for monitoring their designated area. Involved in this are stationary and mobile units [6]. However, there are issues that are attributed to weak enforcement of the existing policy and legal requirements, thereby resulting in a lack of compliance by the regulated communities. Weak enforcement has been attributed to lack of resources, namely: sufficient knowledgeable and skilled manpower, physical infrastructures, and most importantly financial resources [5].

Stations are positioned on the basis of certain criteria like the area being industrial, commercial or residential. At least two people in a team is responsible for taking data from stationary equipment. In the worst case where there is lack of personnel, only one would have to take the reading. The data readings are taken once a weak, to be able to record data per quarter of a month [6].

B. Statement of the Problem

POP's are substances that resist photolytic, chemical and biological degradation. They are generally semi-volatile. The properties of unusual persistence and semi-volatility, coupled with other characteristics, have resulted in the presence of compounds such as Polychlorinated biphenyls all over the world, even in regions where they have never been

used. POP's are ubiquitous. They have been found on every continent, at sites representing every major climatic zone and geographic sector throughout the world [7]. These include remote regions such as the open oceans and deserts, where no significant local sources exist and the only reasonable explanation for their presence is long-range transport from other parts of the globe.

Today, ordinary food supplies in most regions of the world, especially fish, meat and diary products, tend to be contaminated by POP's. Both people and wildlife everywhere in the world, carry burdens of POP's at near levels that can often cause injury to human health and to entire ecosystems [5].

POP's can travel in the environment to regions far from their original source, and then can concentrate in flora and fauna to levels with the potential to injure human health and/or the environment. At present, there is no computerized online system to survey the accumulation of POP's within Metro Manila. The old system includes collecting data from stations specifically designated by the Environmental Management Bureau, and then manually processing the collected data to present the pollutant contamination [6]. Appendix B shows the location of these stations. This process requires time since data from each station would have to be gathered and evaluated. The system will enable this entire process to be done online.

Data provided by the system would help in risk assessment. The system will make it possible for people to attain a certain level of awareness about POP's in their area, and warn them of the threat that these could impose on their health.

C. Objectives

To create an Online Persistent Organic Pollutant Information and Surveying System that will come with the following functionalities:

1) Will allow public users to:
    a. View information(e.g. chemical name, chemical formula, effects, concentration, laws) concerning persistent organic pollutants
    b. View the map marking concentration of different POP's in areas within Metro Manila

2) Will allow field researchers of the Department of Environmental Resources – Environmental Management Bureau to:
    a. View information(e.g. chemical name, chemical formula, effects, concentration, laws) concerning persistent organic pollutants
    b. View the map marking concentration of different POP's in areas within Metro Manila
    c. Add environmental factors(eg. OH radical concentration) from their area of assignment.
    d. Edit account information.
    e. Post/view messages from the bulletin board

3) Will allow the Chemical Analysts of the Department of Environmental Resources – Environmental Management Bureau to:
    a. View information(e.g. chemical name, chemical formula, effects, concentration, laws) concerning persistent organic pollutants
    b. View the map marking concentration of different POP's in areas within Metro Manila

c. Update(add/edit/delete) POP Information (e.g. name, chemical formula, effects)

d. Approve/disapprove POP data submitted by field researchers.

e. Edit account information.

f. Post/view messages from the bulletin board

4) Will allow the System Administrator to:

a. View information(e.g. chemical name, chemical formula, effects, concentration, laws) concerning persistent organic pollutants

b. View the map marking concentration of different POP's in areas within Metro Manila

c. Update(add/edit/delete) user accounts

d. Post/view/delete messages from the bulletin board.

D. Significance of the Study

An online persistent organic pollutant system will disseminate information about individual types of pollutants and their effects on health. Furthermore, the proposed system aims to aid authorities in overseeing the bioaccumulation of POP's by providing them of visual information about the pervasiveness of these pollutants in Metro Manila so that they could take measures to prevent its further transport. Legal issues are also of concern as the system would enable authorities to keep areas in check. It would be dangerous if something as toxic would be left unchecked. Therefore it is only plausible to maintain a system that would map these pollutants and their concentrations. The project will not only benefit the authorities by helping them appraise persistent organic pollutants, but will also be a tool for risk assessment.

E. Scope and Limitations

1. The system is not able to acquire the required data by itself. The values need to be entered to the system by the researchers for it to operate.
2. The level of the POP's is limited within Metro Manila only.
3. The concentration of POP's in an area would be defined in terms of their bioactivity in air and soil in that area.
4. The system can predict future levels of POP concentration only in an area, assuming that there would be no other addition in the present amount. Possible transport of POP's to other areas is outside the system.

II. REVIEW OF RELATED LITERATURE

The website "Persistent Organic Pollutants", by the United Nations Environment Program (UNEP), provide the definition of Persistent Organic Pollutants (POP's) as chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment. It also provides information about POP's project on laboratory capacity, proceedings, reports and documents, information on POP's, their alternatives and alternative approaches, global monitoring of POP's, PCB Activities, and POP's related projects [3].

The Department of Environment and Natural Resources – Environmental Management Bureau (DENR-EMB) is undertaking and inventory of Persistent Organic Pollutants (POP's) as part of the implementation of the Stockholm Convention which is under the umbrella project PHI/01/G32 Philippine Enabling Activity: Initial Assistance to the Philippines to Meet its Obligations under the Stockholm Convention on POP's [4].

A study entitled "A model assessing bioavailability of persistent organic pollutants in soil" [8] proposed a model for describing persistent organic pollutants (POP's) bioavailability in soil. The model is written in Fortran 90 and describes POPs' behaviour as resulting from four different processes: sorption-desorption equilibrium, slow diffusion (aged fraction), fast irreversible sorption (bound residues) and biodegradation of the bioavailable fraction. The study concluded that the proposed five compartment model can be used along with experimental data to predict the organic contaminants bioavailability in the course of time.

The Meteorological Synthesizing Centre-East (Moscow, Russia) as an international centre of Co-operative Programme for Monitoring and Evaluation of Long-Range Transmission of Air Pollutants in Europe (EMEP) was established in 1979. During the recent

decades considerable attention has been given to problems concerning negative effects of heavy metals (HMs) and persistent organic pollutants (POP's) on various ecosystems in different environmental media. A range of projects related to the long-range atmospheric transport of these substances are being carried out by several international organizations and programmes. An essential progress in the field of assessment of HMs and POP's air pollution was achieved within the framework of the UN ECE Convention on Long-Range Transboundary Air Pollution (CLRTAP). Since 1995 MSC-E has focused on the research and modelling the long-range transport of POP's and HMs. Transport modeling of the pollutants requires detailed knowledge of mechanisms of HMs and POP's input to the atmosphere, transport processes, scavenging and accumulation in different environmental compartments [9]. Meteorological Synthesizing Centre-East is responsible for development and operational use of numerical models of HMs and POP's airborne transport. They maintain a database about POP's and HM's, specially the chemical properties of the substances involved which they use to determine their behavior.

The California Air Resources Board monitors particulate matter pollutants to demonstrate attainment or non-attainment of national and state ambient air standards [10]. Particulate monitoring can be divided into two main categories: monitoring of particulate matter with an aerodynamic diameter of 10 microns or less (PM10) and monitoring for particulate matter with a diameter of 2.5 microns or less (PM2.5). Data that have been collected is stored in their database and made available online.

The Mississippi Department of Environmental Quality (MDEQ) conducts air monitoring within their area. Ambient monitoring for hazardous air pollutants is conducted to improve MDEQ's characterization of air quality for hazardous air pollutants. This monitoring is producing measured concentrations of hazardous air pollutants in areas of the state where such emissions may be present. Information is made available online and

comes in the form of maps. This information is to be used in plans and decisions to address needed improvements in air quality with respect to toxic emission concentrations. The ambient monitoring that is being performed includes sampling for volatile organic compound hazardous air pollutants and carbonyl compounds[11].

The National Park Service Air Resources Division operates a network of air quality monitoring stations (sometimes refered to as the Gaseous Pollutant Monitoring Network - GPMN) that measures primarily meteorological parameters and ozone. The standard NPS monitoring station measures ozone using a UV-absorption analyzer, a transfer standard, a weather station including wind speed, wind direction, temperature at two heights, solar radiation, relative humidity, and a wetness sensor, a stacked filter-pack designed to measure sulfate, sulfur dioxide, nitrate, ammonium, and nitric acid, and at some sites a sulfur dioxide analyzer. Operators for the stations are provided by the parks and a contractor maintains and calibrates the network equipment. Data is transmitted nightly over the phone by a contractor who validates and archives the data. Hourly data files are transfered to the Environmental Protection Agency (EPA) Air Quality Systems database and made available on the web [12].

NASA's Global Change Master Directory (GCMD) hosts a new look and new search capability which includes air pollutant monitoring data. The GCMD database holds more than 16,000 descriptions of Earth science data sets and services covering all aspects of Earth and environmental sciences [13]. The primary goal of GCMD is to enable users to locate and obtain access to Earth science data sets and services relevant to the global change and Earth science research by accessing these information online.

The study entitled "Spatial Characteristics Of Fine Particulate Matter And Nitrogen Dioxide In Seattle: Identifying Representative Monitoring Sites" by Emily Goswami ,Master of Science, Environmental Health Technology, Department of Environmental and

Occupational Health Sciences, involves detecting sources of pollutants, and investigating the health effects of air pollution through epidemiological studies. The effectiveness of monitoring depends on how representative monitoring sites are of overall ambient concentrations to which a population is most exposed [14].

A POP's assessment report provides POP information on countries that have taken action to ban or severely restrict compounds is derived from multiple sources dating back to 1987 [15]. POP's included in the list are dieldrin, Polychlorinated biphenyls, and hexachlorobenzene.

III. THEORETICAL FRAMEWORK

A. PERSISTENT ORGANIC POLLUTANTS

Persistent organic pollutants (POP's) are organic compounds that, to a varying degree, resist photolytic, biological and chemical degradation. POP's are often halogenated and characterised by low water solubility and high lipid solubility, leading to their bioaccumulation in fatty tissues. They are also semi-volatile, enabling them to move long distances in the atmosphere before deposition occurs [4].

POP's are persistent in the environment. This means that they are substances that resist photolytic, chemical and biological degradation. They are generally semi-volatile. Persistent substances with this property tend to enter the air, travel long distances on air currents and then return to earth. They are also subject to global distillation (i.e. migration from warmer to colder regions) [7].

Because they generally have low water solubility and high lipid (fat) solubility, they tend to bioaccumulate in fatty tissues of living organisms. In the environment, concentrations of these substances can magnify by factors of many thousands as they move up the food chain [7].

Effects to Human Health

Scientists have observed a range of health injuries in wildlife exposed to POP's. Effects like reproductive failure and population declines, abnormally functioning thyroids and other hormone system malfunctions, feminization of males and masculinization of females, compromised immune systems, behavioral abnormalities, tumors and cancers; and gross birth defects [7].

Good evidence associates human exposure to specific POPs' health effects like:

- Cancers and tumors;
- Neurobehavioral impairment including learning disorders and changes in temperament;
- Immune system changes;
- Reproductive deficits and sex-linked disorders.

B. MSCE-POP MODEL DESCRIPTION

This MSCE-POP model developed by the Meteorological Synthesizing Centre-East (MSC-E) evaluates environmental pollution by persistent organic pollutants (POP's) [9].

MSCE-POP model is being developed for several purposes:

- evaluation of atmospheric transport and deposition of POP's;
- evaluation of spatial distribution of POP's in the atmosphere, soil, vegetation, and seawater;
- evaluation of POP partitioning between main environmental compartments;
- assessment of temporal and spatial trends;
- projection of future levels of POP contamination;
- estimation of long-range transport potential and overall persistence of new potential POP's;
- study of environment pollution by POP's on the basis of monitoring/modelling approach.

The structure of MSCE-POP model

Atmosphere, soil, seawater, and vegetation are the main environmental compartments that are included in the MSCE-POP model. This includes basic processes describing POP emission, long-range transport, deposition, degradation, and gaseous exchange between the atmosphere and the underlying surface. MSCE-POP model domain covers practically the whole troposphere, upper layer of soil of 20 cm, and seawater compartment.

Degradation on the atmospheric compartment

The gas-phase reaction of pollutants with hydroxyl radicals and all other reactions are neglected during degradation. The process of degradation in the atmosphere is described by the equation of the second order:

$$\frac{dC}{dt} = -k_{air} \cdot C \cdot [OH]$$

Where C is the pollutant concentration in air (gaseous phase), ng/m^3;

[OH] is the concentration of OH radical, molec/cm^3;

k_{air} is the degradation rate constant for air, cm^3/(molec.s).

where the temperature dependence of the parameter *k* is provided by the equation:

$$k = A \cdot \exp(-E_a / RT),$$

where *A* is the exponential multiplier;

Ea is the activation energy;

R is the universal gas constant;

T is the ambient air temperature.

For some of considered POP's, the MSCE-POP model the assume the degradation rate constant due to the fact that reaction with OH-radical in the atmosphere is taken to be

temperature dependent. Concentrations of OH radicals in the atmosphere vary substantially depending on factors like latitude, cloudiness, day time, season, some atmospheric properties, etc. The process of degradation of POP's associated with particles is *not included* in the model due to lack of information on this topic.

Degradation over the soil compartment

The degradation process in soil is described as a first-order process by the equation:

$$\frac{dC}{dt} = -k_{soil}C$$

Where C is the pollutant concentration in soil, ng/m_3;

k_{soil} is the degradation rate constant for soil, s^{-1}.

The degradation rate constant k_{soil} is a part of model parameterization for a given pollutant.

C. INFORMATION SYSTEM

An entire infrastructure, organization, personnel, processing, storage, transmission, display and disposition of information. It is a system, whether automated or manual, that comprises people, machines and methods organized to collect, process, transmit and disseminate data that represent user information [16].

D. GEOGRAPHIC INFORMATION SYSTEM

GIS is a technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework. GIS links location to information (such as people to addresses, buildings to

parcels, or streets within a network) and layers that information to give you a better understanding of how it all interrelates [16].

People map quantities, like where the most and least are, to find places that meet their criteria and take action, or to see the relationships between places. This gives an additional level of information beyond simply mapping the locations of features. By mapping where and how things move over a period of time, you can gain insight into how they behave [17].

IV. DESIGN AND IMPLEMENTATION

A. Entity Relationship Diagram

Figure 1 shows the Entity Relationship Diagram of the Persistent Organic Pollutant Information and Surveying System. Corresponding attributes for each entities are shown in figures 2 to 5.

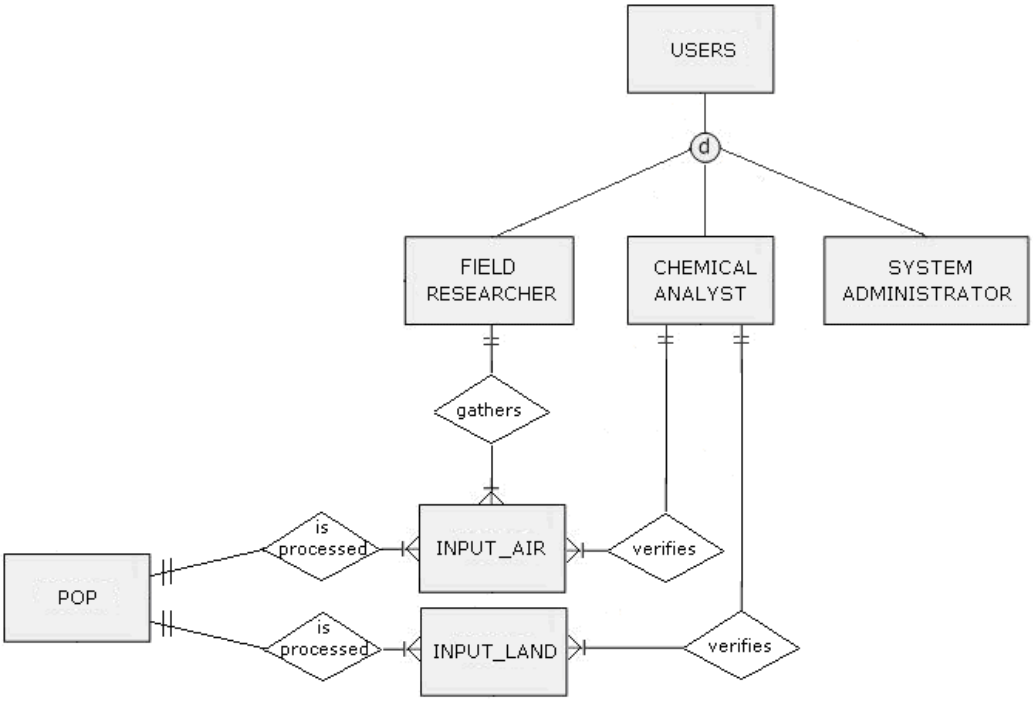

Figure 1. Entity Relationship Diagram, Persistent Organic Pollutant Information and Surveying System

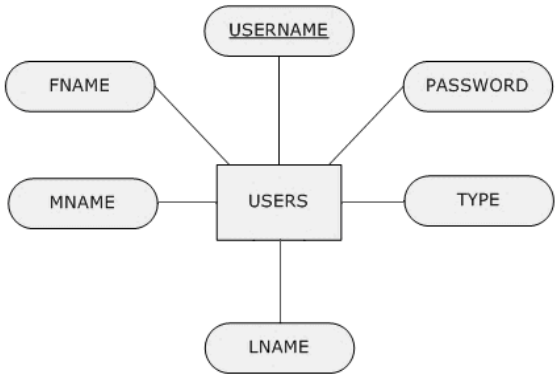

Figure 2. Users Entity's Attributes, Persistent Organic Pollutant Information and Surveying System

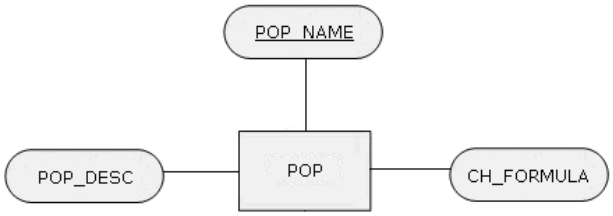

Figure 3. Persistent Organic Pollutants Entity's Attributes, Persistent Organic Pollutant Information and Surveying System

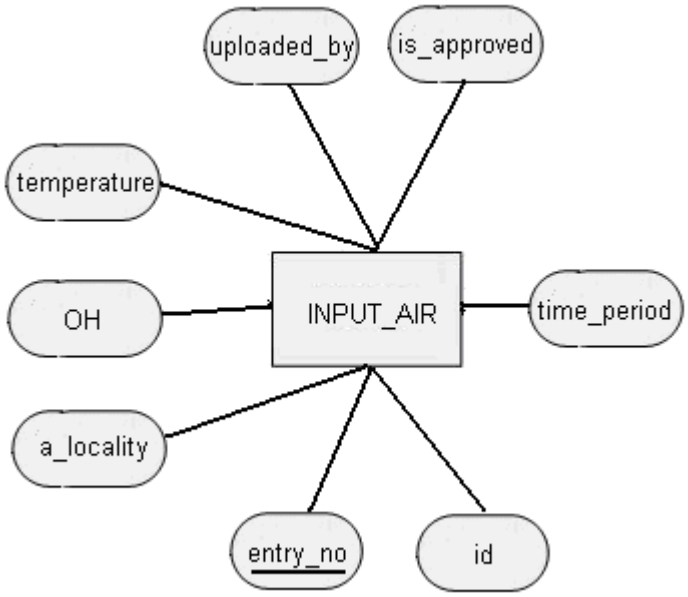

Figure 4. Input_Air Entity's Attributes, Persistent Organic Pollutant Information and Surveying System

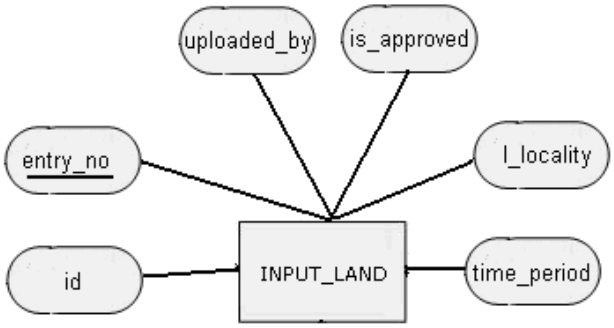

Figure 5. Inpur_Land Entity's Attributes, Persistent Organic Pollutant Information and Surveying System

B. Data Dictionary

USERS Table – store user information/user accounts

FIELD	DATA TYPE	DESCRIPTION
USERNAME	VARCHAR(10)	User account name
PASSWORD	VARCHAR(10)	Password
USERTYPE	ENUM('RES','CA','SA')	Type of user : researcher, chemical analyst or system administrator
FNAME	VARCHAR(30)	First name
MNAME	VARCHAR(30)	Middle name
LNAME	VARCHAR(30)	Last name

POP Table

FIELD	DATA TYPE	DESCRIPTION
id`	int(8)	Pollutant identifier
comm._name	varchar(250)	Common name
chem._name	varchar(100)	Chemical name
Synonyms	Text	Other known names
molec_formula	varchar(50)	Molecular formula
molec_weight	Double	Molecular weight
boiling_pt	Double	Boiling point
State	Varchar(100)	State of matter
vap_pressure	Varchar(100)	Vapor pressure
solubility_water	varchar(50)	Water solubility
solubility_other	varchar(200)	Solubility in other substance
Color	varchar(50)	Color
Odour	varchar(50)	Odor
Description	text	Description of pollutant
A	double	Exponential multiplier, A
Ea	double	Activation energy, Ea
Ksoil	double	Soil degradation constant

INPUT_AIR Table – stores all input data related to the atmosphere

FIELD	DATA TYPE	DESCRIPTION
entry_no	int(8)	Data entry number
Id	int(8)	Id of the POP being described by the data
temperature	double	Temperature
OH	double	OH radical concentration
time_period	varchar(25)	Time data was entered
a_locality	Text	Areas contaminated
Uploaded_by	varchar(10)	Uploaded by
Approved_by	varchar(10)	Approved by

is_approved	tinyint(1)	Is approved or not

INPUT_LAND Table – stores all input data related to the land

FIELD	DATA TYPE	DESCRIPTION
entry_no`	int(8)	Data entry number
id`	int(8)	Id of the POP being described by the data
time_period	varchar(25)	Time data was entered
l_locality`	Text	Areas contaminated
Uploaded_by	varchar(10)	Uploaded by
approved_by	varchar(10)	Approved by
is_approved	Tinyint(1)	Is approved or not

C. Context Free Diagram

Entities involved with the system include the Public Users, the Field Researchers, the Chemical Analysts, and the System Administrator. Public users would input what they would want to view and the system outputs the corresponding data. The other system users can also do the same. The primary function of the Field Researcher is to input into the system environmental data related to POP's. The Chemical Analyst would be responsible for entering pollutant records into the system. He/she is also responsible for approving data submitted by the Field Researcher. Lastly, the System Administrator is solely responsible for managing user accounts. The Context Free Diagram illustrates the entities as shown in Figure 6.

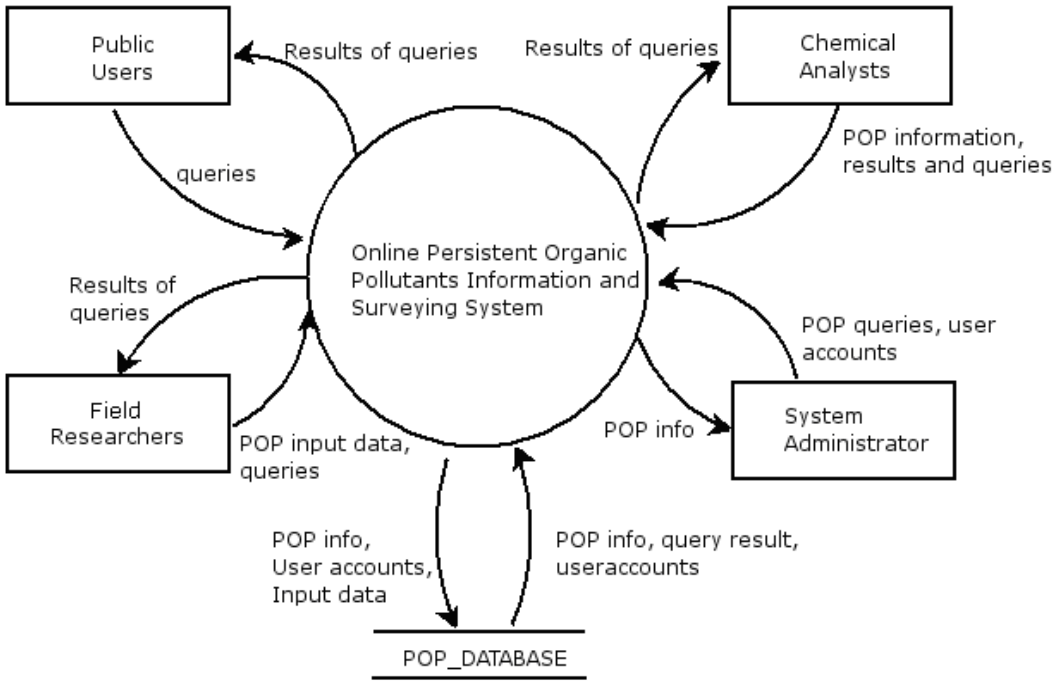

Figure 6. Context Flow Diagram, Persistent Organic Pollutant Information and Surveying System

D. Data Flow Diagram

Figure 7 shows the Data Flow Diagram. It illustrates the different processes in the system. Public users would input queries/what they would want to view, and then the system outputs the corresponding data. Other system users can also do the same. Although, the Field Researcher, the Chemical Analyst and the System Administrator would have to log in and obtain access rights for them to perform their functions. The primary function of the Field Researcher is to input into the system environmental data related to POP's. The Chemical Analyst would be responsible for entering pollutant records into the system, and is also responsible for updating these records He/she is also responsible for approving data submitted by the Field Researcher. Lastly, the System Administrator is solely responsible for managing user accounts.

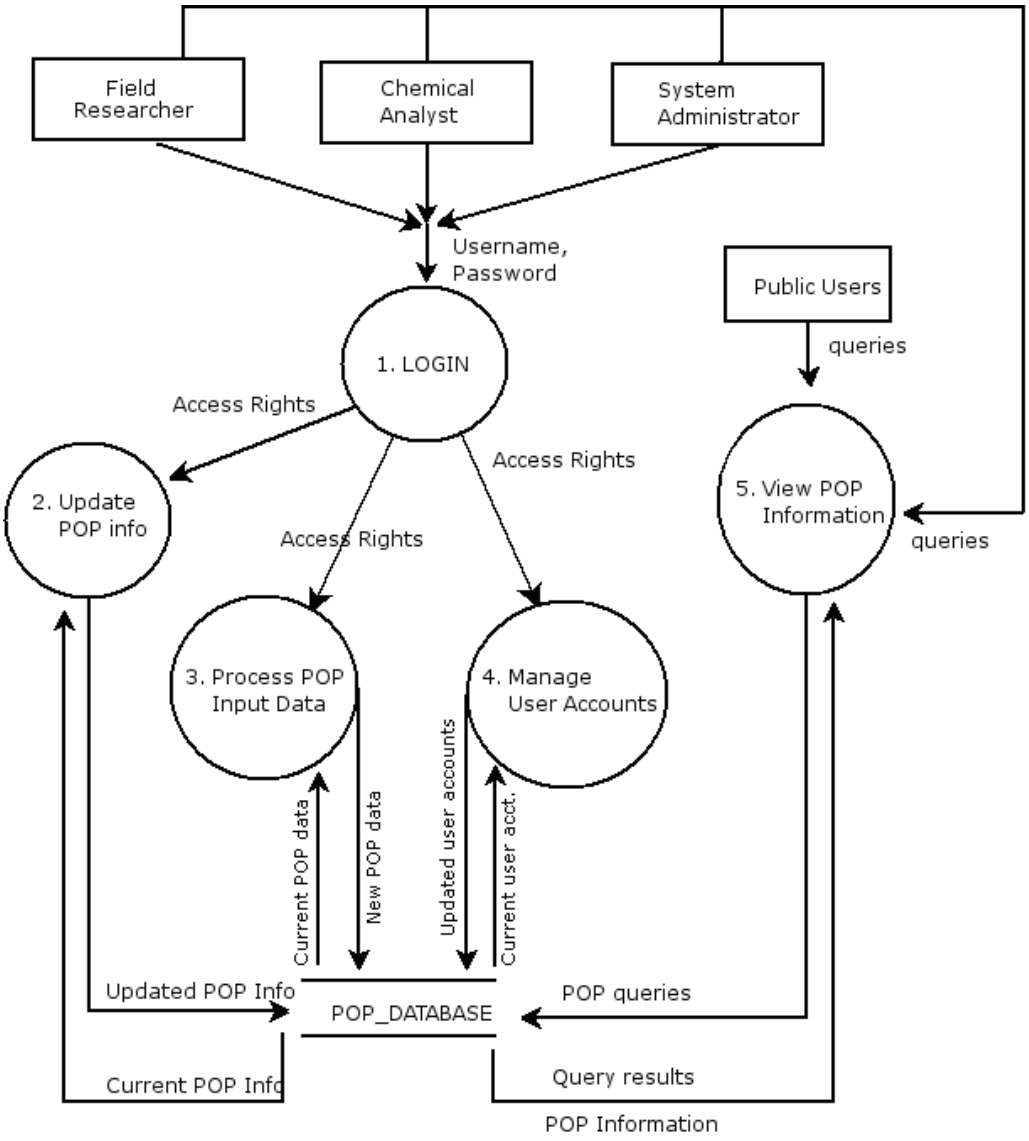

Figure 7. Data Flow Diagram, Persistent Organic Pollutant Information and Surveying System

Process 2.0, Update POP Info (shown in Figure 8), is mostly involved in adding/editing the pollutant records. This process is executed by the Chemical Analyst. He/she has the option of either adding a new POP record, or editing an existing POP record.

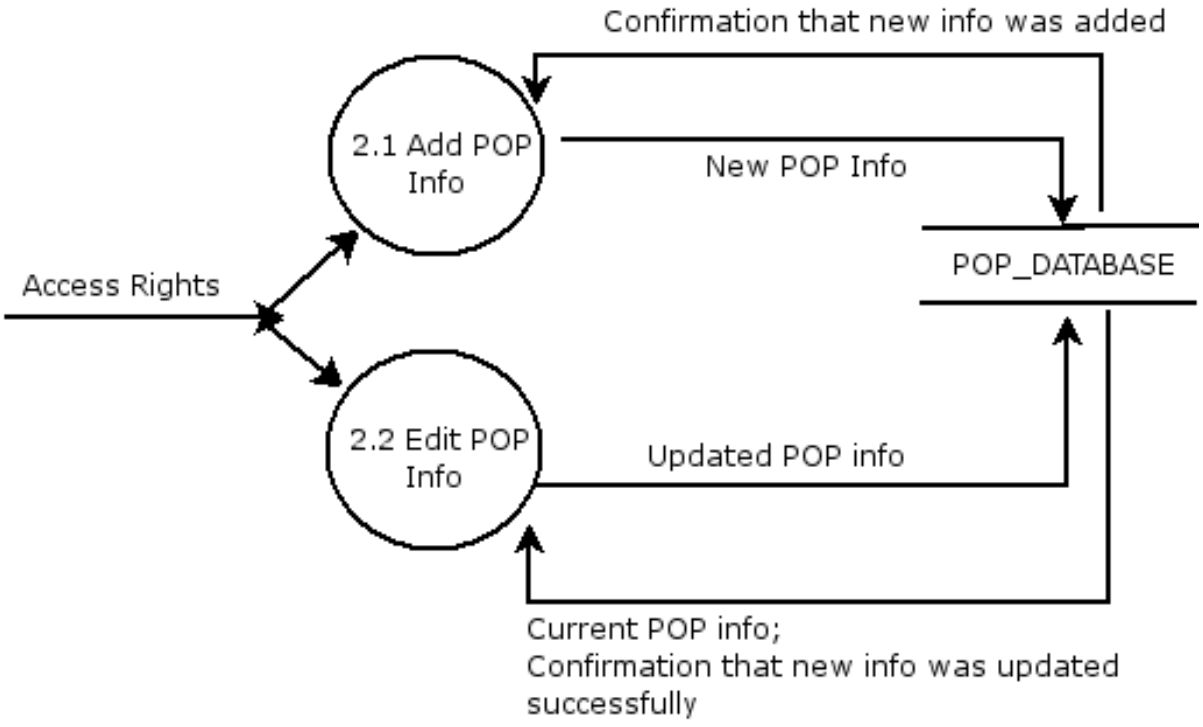

Figure 8. Sub-explosion of Process 2.0, Update POP Info, Persistent Organic Pollutant Information and Surveying System

Process 3.0, Process POP Input Data (shown in Figure 9) involves adding/approving/disapproving the POP environmental data. Process 3.0 is subdivided into two processes (shown in Figure 10). Process 3.1 is executed by the Field Researcher. He/she can only add environmental data. Process 3.2 is done by the Chemical Analyst, who approves/disapproves data submitted by the Field Researcher.

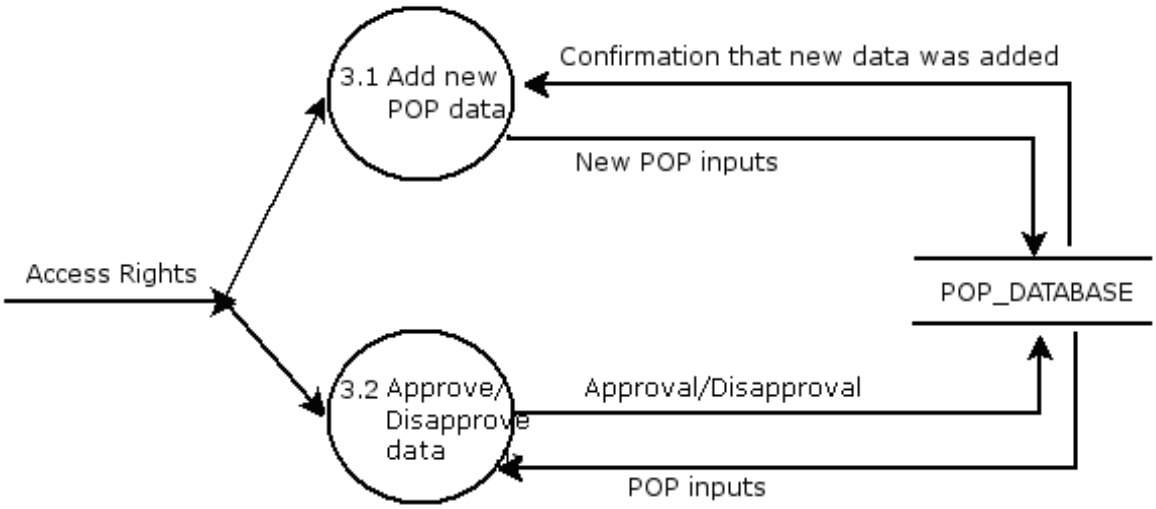

Figure 9. Sub-explosion of Process 3.0, Process POP Input Data, Persistent Organic Pollutant Information and Surveying System

Process 4.0, Manage User Accounts, (shown in Figure 10) is handled by the System Administrator. He/she has the option of adding accounts, and either enabling or disabling user accounts. Process 5.0, View POP Information, (shown in Figure 11) involves all system users. There is no need to gain access rights to perform process 5.0. The user would simply input his/her queries and the system would respond by outputting the requested data.

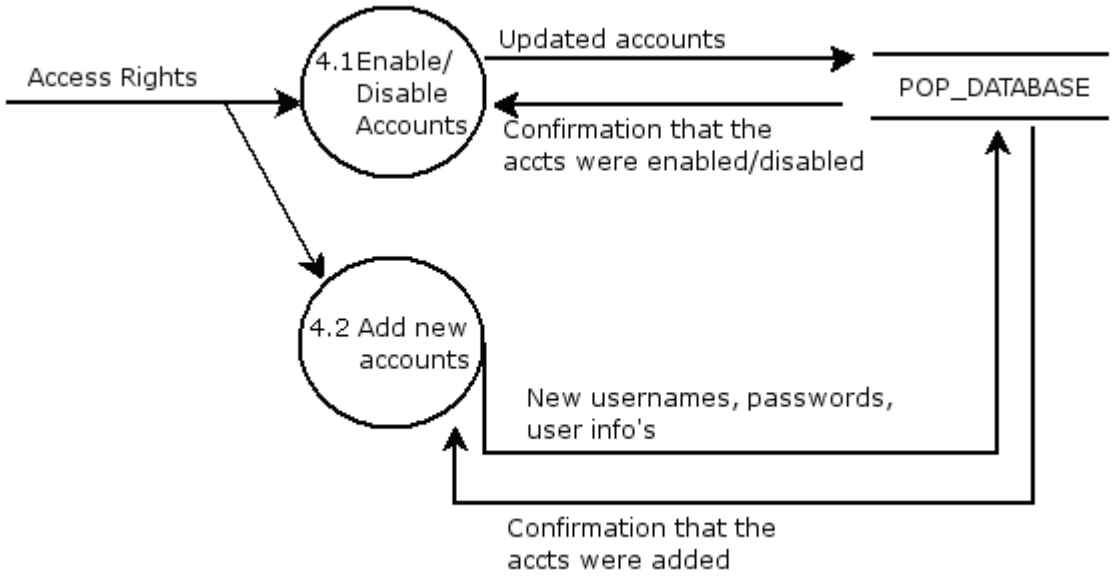

Figure 10. Sub-explosion of Process 4.0, Manage User Accounts, Persistent Organic Pollutant Information and Surveying System

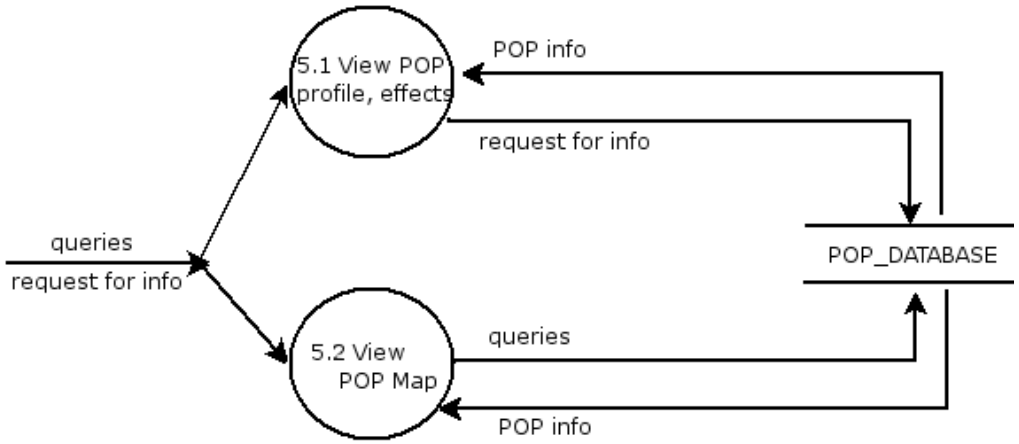

Figure 11. Sub-explosion of Process 5.0, View POP Information, Persistent Organic Pollutant Information and Surveying System

E. Technical Architecture

The system will use Personal Homepages (PHP), which by the way is an open source technology, as server side technology. A request sent for a PHP page from a client is passed to the PHP interpreter by the server along with various program variables. A software program maple will be used for computations. Visual output would be presented through Flash.

TECHNICAL REQUIREMENTS:

1. The Server Machine

    Hardware Requirements:

        Processor - at least 500 MHz
        RAM - at least 128 MB
        Memory - at least 500 MB

    Software Requirements

        Operating System - at least Windows '98
        Scripting Language - PHP
        Database Platform - MySQL
        Web Server - Apache HTTP Server
        Flash
        Maple

2. Client Machine

    Software Requirements

        Operating System - at least Windows '98
        Internet Access
        Flash Plug-in

V. RESULTS

The homepage of the *Online Persistent Organic Pollutants Information and Surveying System* is shown in Figure 12. The system has general users and registered users. While the user is not registered, the log-in panel will be constantly displayed on the left corner. In this panel, the user is required to input his username and password. Other menu items appearing in this page includes:

POP – provides information on the different types of POP such as PCB, etc.

Map – Map of Metro Manila showing the contaminated areas and their respective contamination levels at present; prediction of future levels is also possible

Archive – features recent contamination levels

FAQ – common questions about POPs

Legislations – Laws and regulations that involves POP's

The page also includes links on acquiring Mozilla Firefox and Flash Player 7 plug-in, which are required for the system to function.

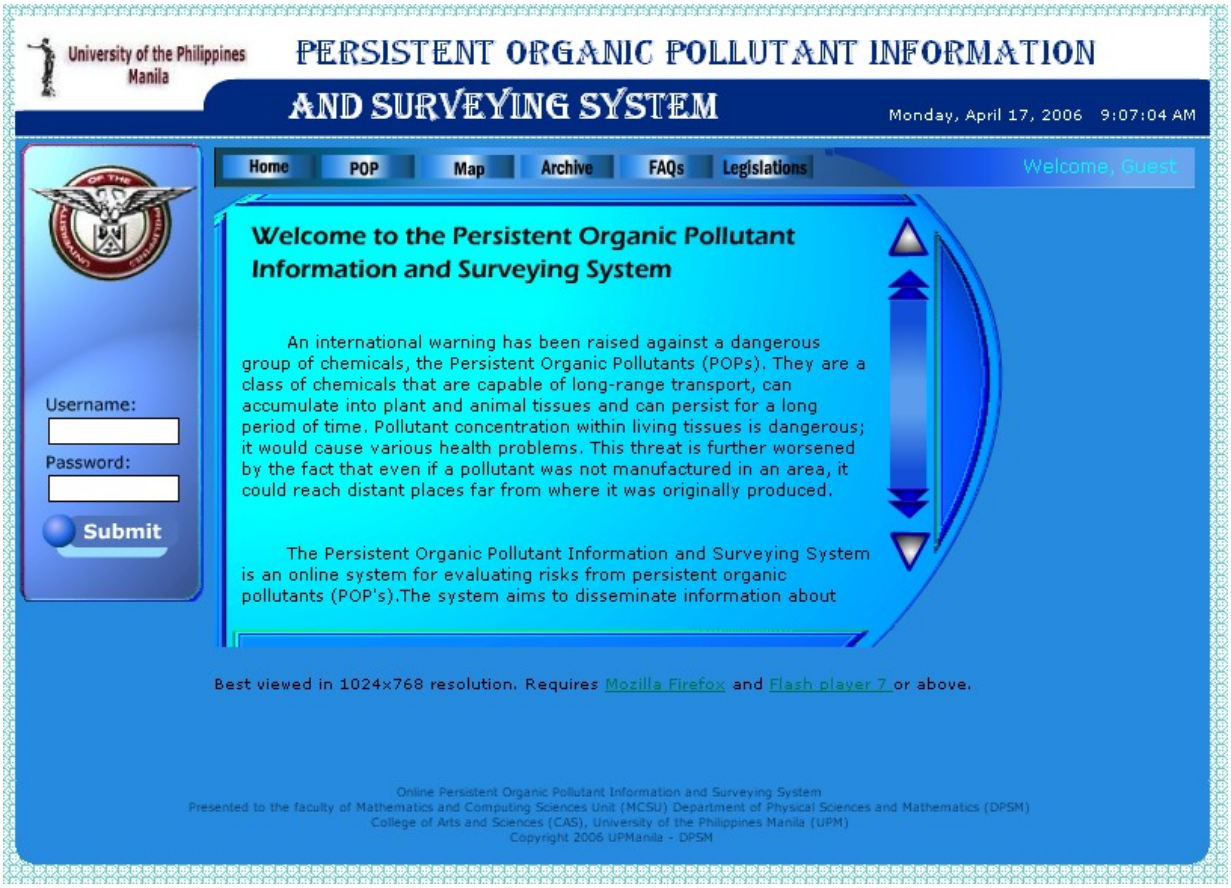

Figure 12. Homepage, Persistent Organic Pollutant Information and Surveying System

The Persistent Organic Pollutant Information section contains information about the different types of pollutants (shown in figure 13). This includes pollutant common anme, chemical name, other known names, physical characteristics and chemical properties.

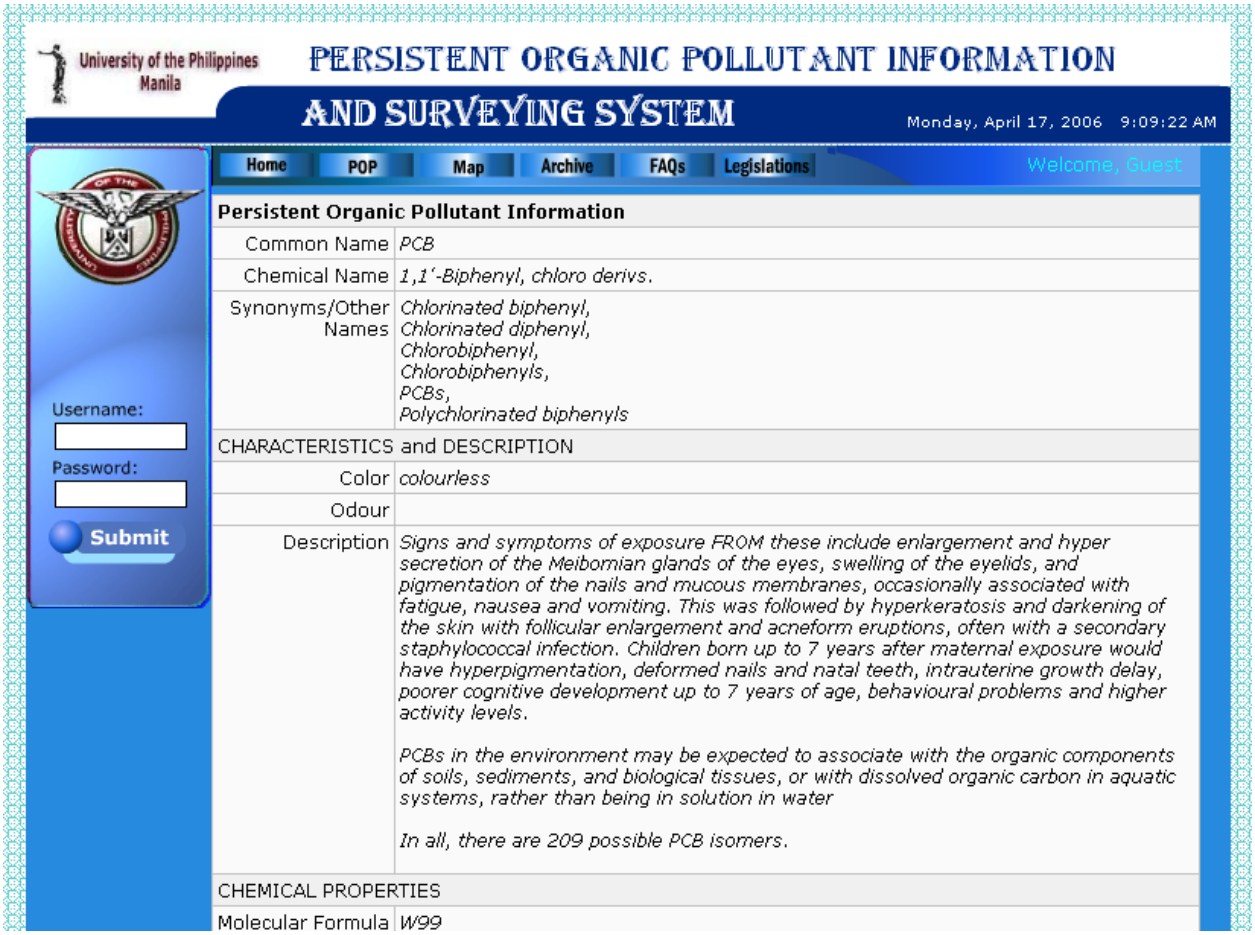

Figure 13. Pollutant Information page, Persistent Organic Pollutant Information and Surveying System

Figure 14 shows the map of pollutant concentration levels. This page can be accessed by clicking "Map" in the menu bar. The button which appears within the map enables the user to see present and predicted pollutant concentration levels (see figure 15).

The system has three types of registered users: the field researchers, the chemical analyst and the system administrator. Common among these three users is that they are able to access the bulletin board (shown in figure 16) and that they are able to update their own user profile and/or change their password (shown in figure 17).

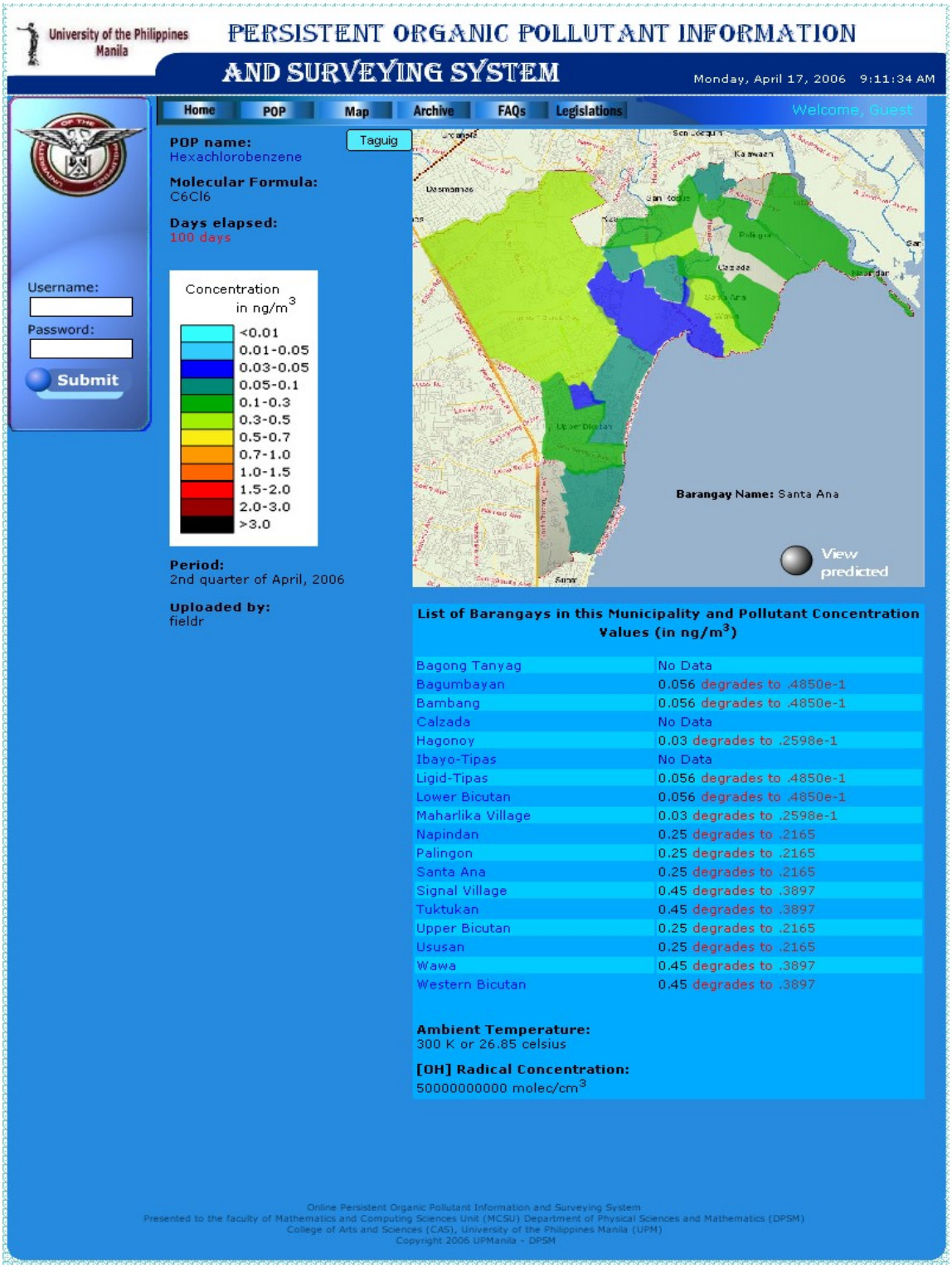

Figure 14. Map Showing Pollutant Concentration, Persistent Organic Pollutant Information and Surveying System

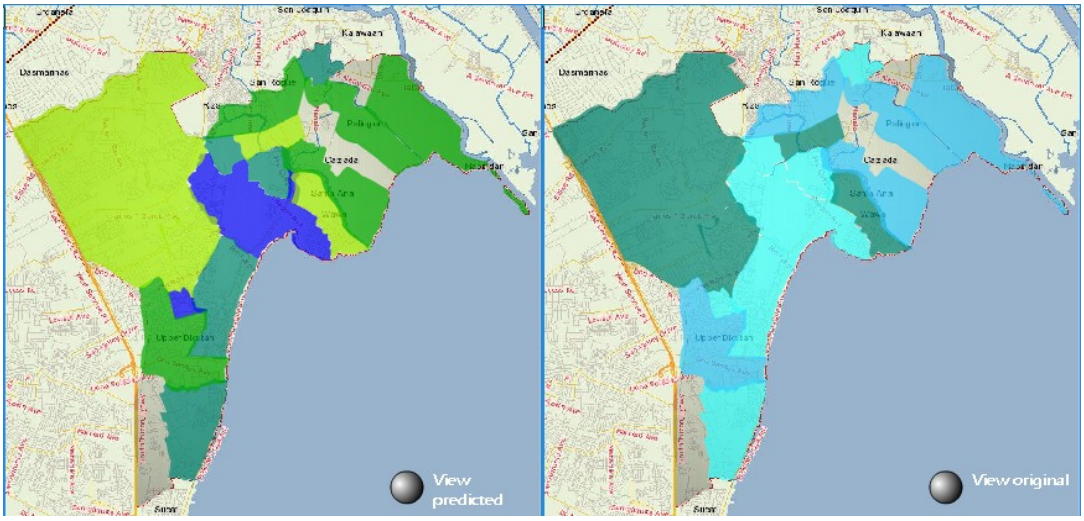

Figure 15. Map Showing Present and Predicted Pollutant Concentration, Persistent Organic Pollutant Information and Surveying System

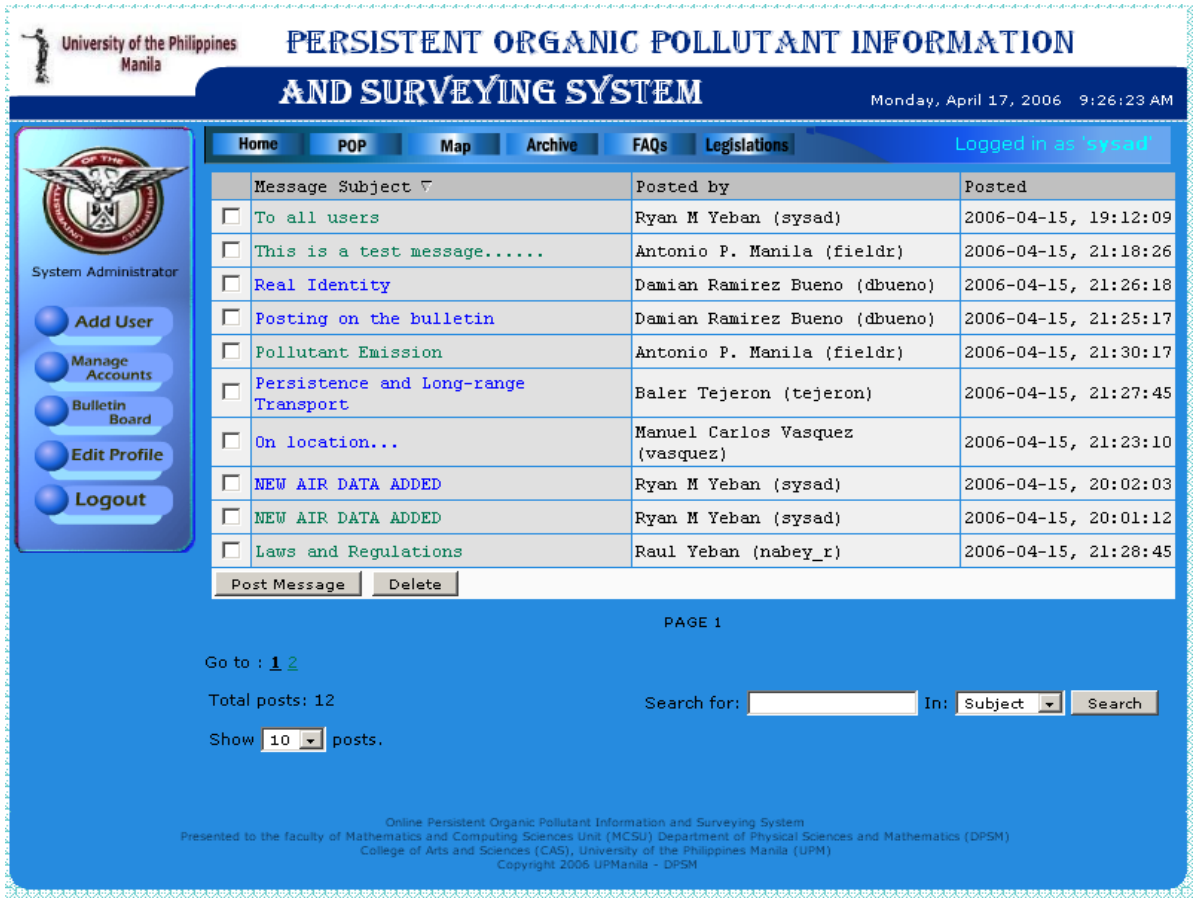

Figure 16. The Bulletin Board, Persistent Organic Pollutant Information and Surveying System

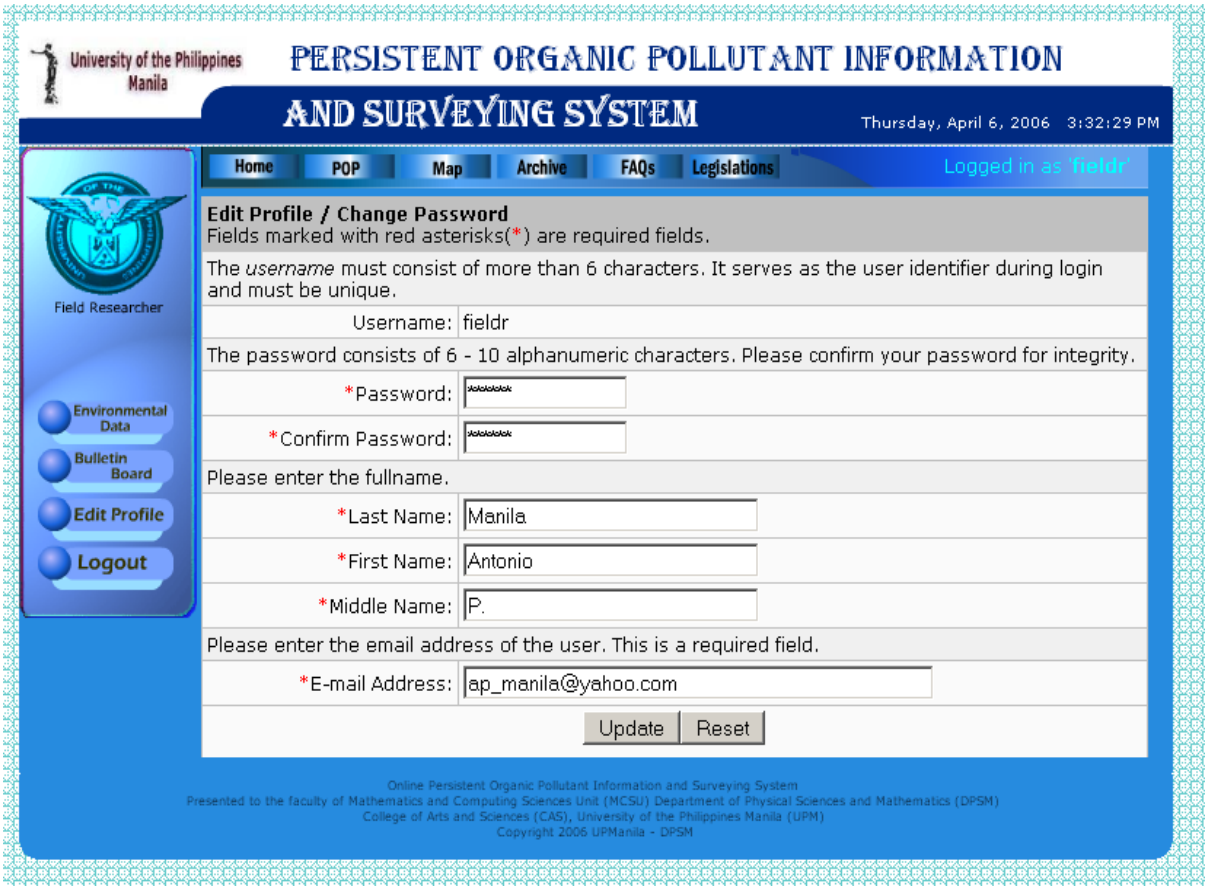

Figure 17. Update Profile/Change Password, Persistent Organic Pollutant Information and Surveying System

Unique to the field researcher is that he/she is the only one who could input environmental data into the system (shown in figure 18). This data is crucial for tracking the amounts of POP's. These are also important in predicting the future amount of POP's in an area.

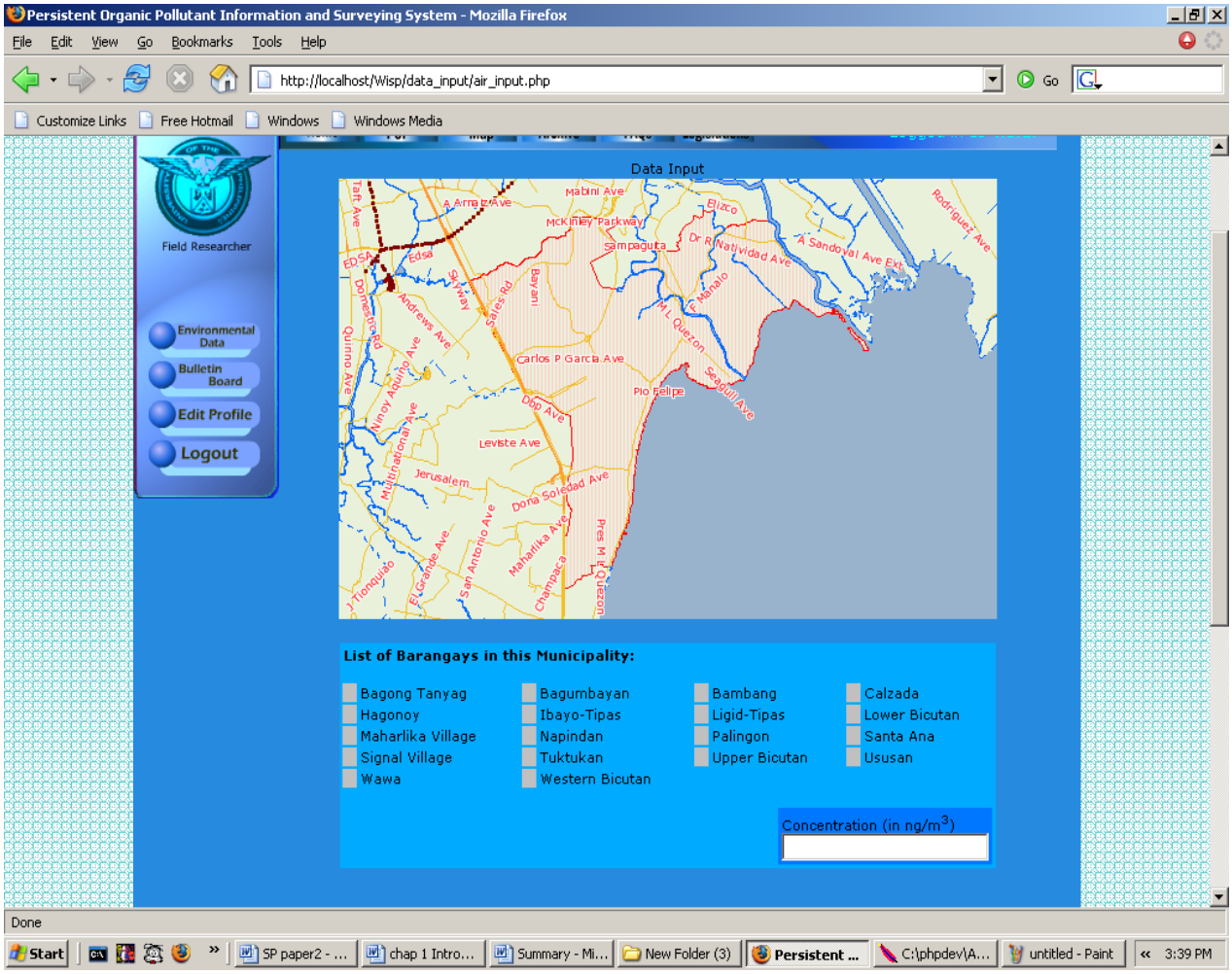

Figure 18. Data Input, Persistent Organic Pollutant Information and Surveying System

The chemical analyst is the second type of registered user. He/she is able to add/update POP records (shown in figure 19), and also approve/disapprove data submitted by field researchers (shown in figure 20).

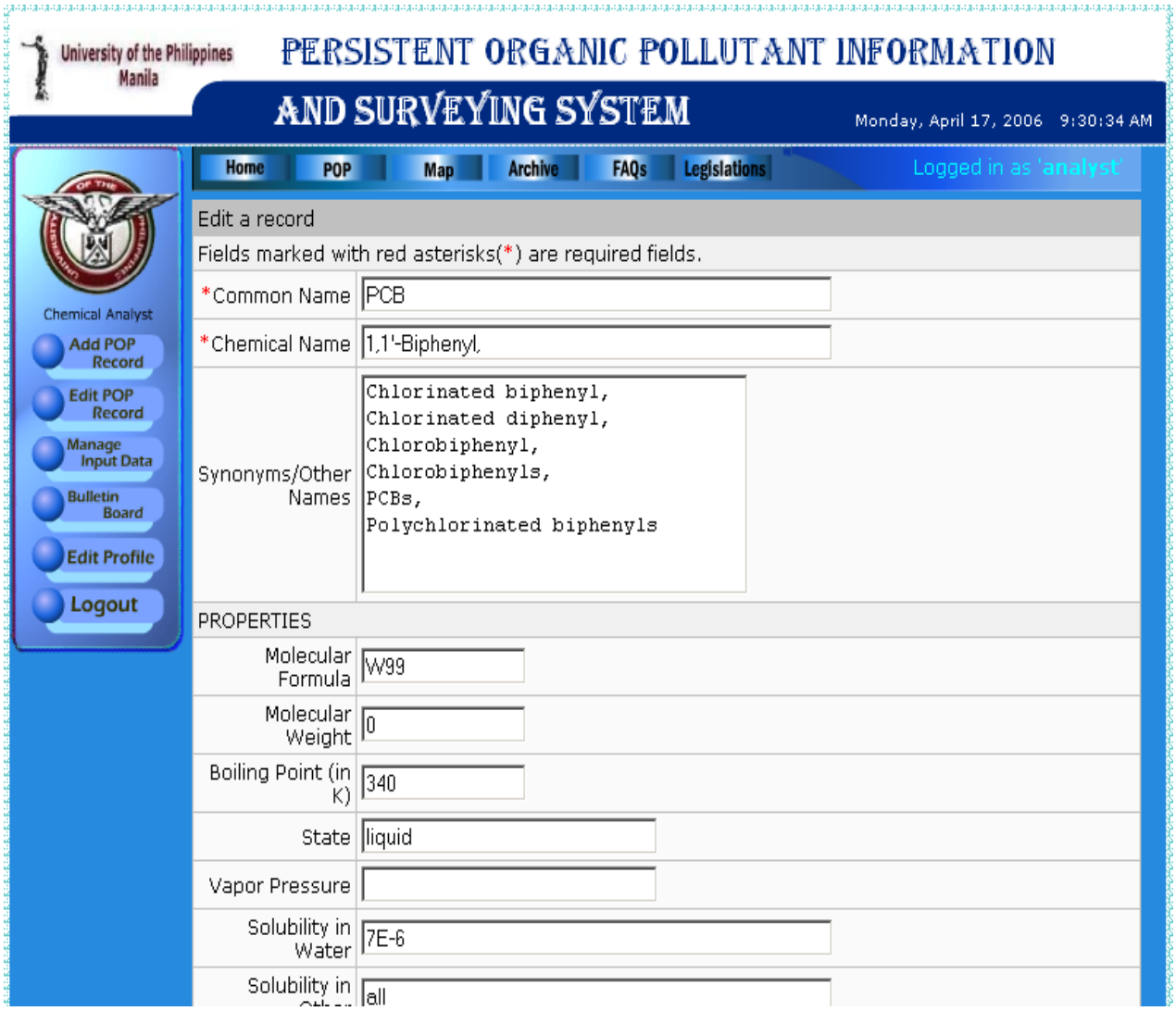

Figure 19. Add POP record, Persistent Organic Pollutant Information and Surveying System

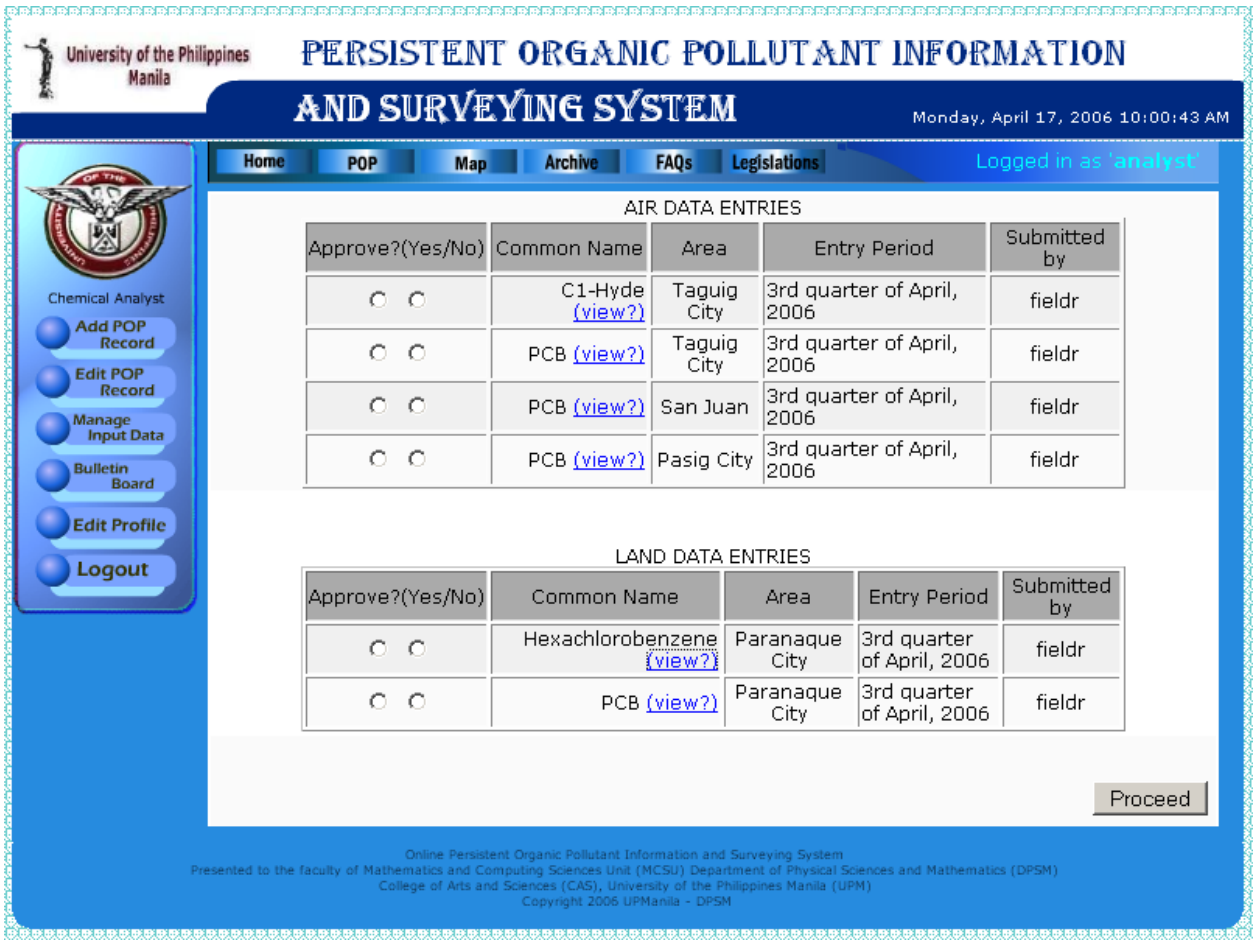

Figure 20. Approve/Disapprove submitted data, Persistent Organic Pollutant Information and Surveying System

Lastly, the system administrator has the task of managing user accounts (shown figure 21). The system administrator is the only user who could enable/disable accounts, as well as manage the bulletin board.

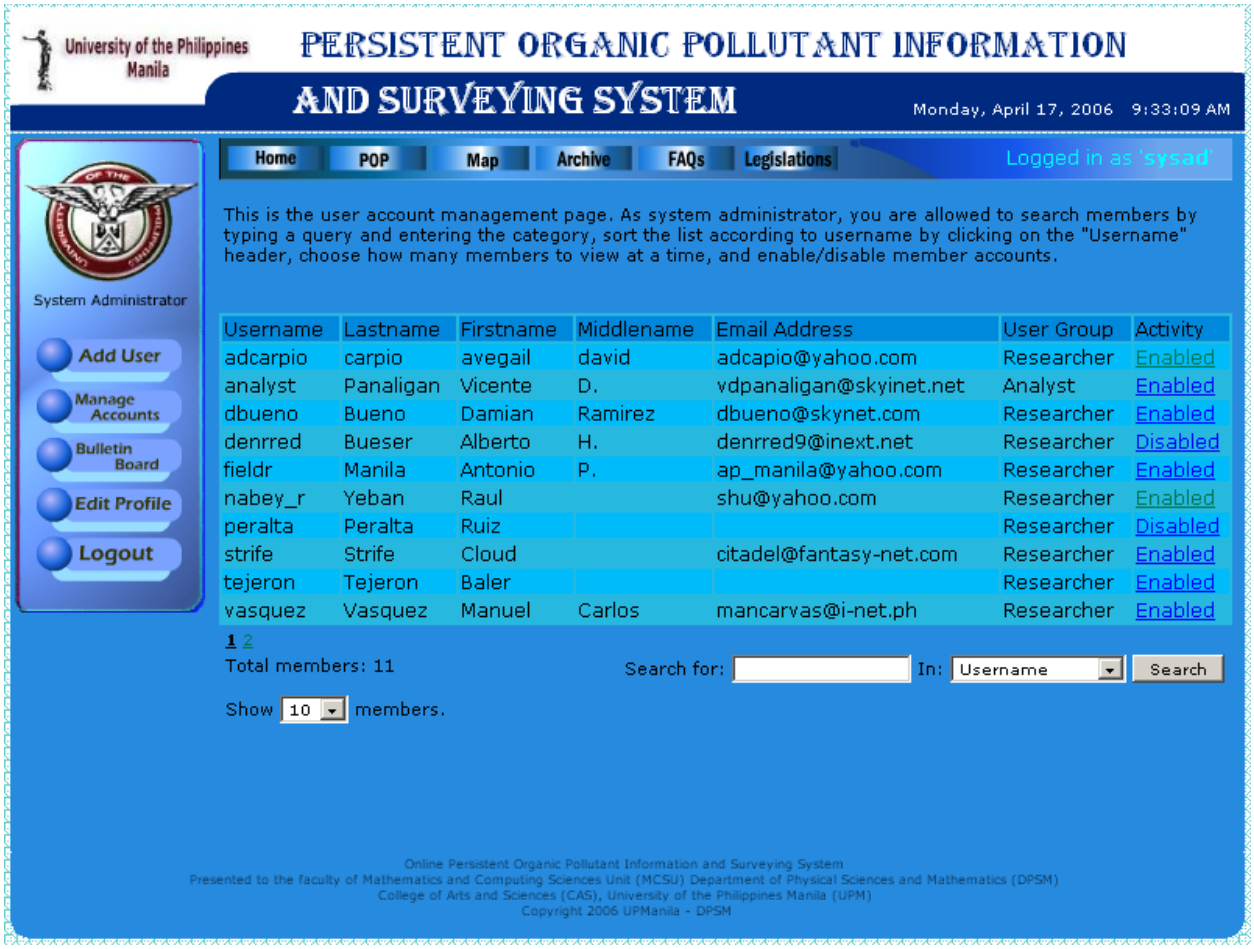

Figure 21. Manage user accounts, Persistent Organic Pollutant Information and Surveying System

VI. DISCUSSION

The online persistent organic pollutant information and surveying system is a system that provides information mainly about the concentration of persistent organic pollutants(POP's) in Metro Manila. The system is to able to present POP data into a map which would show the present and future concentration of the different POP's within Metro Manila, given some limitations. The system is presented via GIS(Geographical Information System).

Though the system is able to make predictions of the future levels of POP's concentration, it neglects transfer of pollutants from other areas and also disregards pollutants produced after the data's time of entry. Also, concentration of POP's in an area would be defined in terms only of their bioactivity in air and soil in that area. The system also has no means of gathering data by itself due to the absence of hardware that can automatically collect data.

The primary concern of the system is to present to the users information about the spread of persistent organic pollutants in Metro Manila. This information include the type of pollutant, its effects, its properties and description. The concentration of pollutants are also displayed in the map. Different pollutant record are stored in the database. The user may view these information by accessing the map or by viewing the description of the pollutant. As for the concentration of the pollutants, it is presented via GIS. The user may also input the span of time which will predict future concentration. This is system's main difference compared to other systems, since other systems would only present a static map. The system makes it available for users to see two maps: one presenting the current pollutant contamination and the other presenting the predicted

level of contamination. Also, compared to other systems, concentration of POP's in an area would be defined only in terms of their bioactivity in air and soil in that area.

The system also contains a bulletin board for registered users to discuss issues about persistent organic pollutants. The bulletin board is managed by the system administrator and he/she is the only one allowed to delete posts from it.

A persistent organic pollutant system is intended for users to have a greater view of the risks involved in being exposed to POP's. The system aims to aid authorities in overseeing the bioaccumulation of POP's by providing them of visual information about the pervasiveness of these pollutants in Metro Manila so that they could take measures to prevent its further transport. Benefits of POP monitoring include prevention of POP production in an area, so that if any establishment is responsible for production of POP's, legal measures could be done. Also, if pollutant contamination is excessive in an area, the authorities could announce a warning to the citizens in that area. It would be advantageous to know the type of pollutant and its effects; people would be aware of the signs and symptoms, and if ever the worst happens, the authorities could distribute the proper remedies and do the proper treatment to the affected individuals.

VII. CONCLUSION

The Online Persistent Organic Pollutant System will disseminate information about individual types of pollutants and their effects on health. It would be dangerous if something as toxic as POP's would be left unchecked. Therefore it is only plausible to maintain a system that would map these pollutants and their concentrations.

Information provided by the Online Persistent Organic Pollutant Information and Surveying System includes pollutant common name, chemical name, chemical formula, chemical properties and concentration in the different areas of Metro Manila. The system also enables the user to see the future concentration of pollutants.

All users are able to view chemical properties, contaminated areas and POP description. They are also able to view laws, republic acts, and other legislations concerning persistent organic pollutants. Only registered users are able to post in the message boards. Only the system administrator is able to delete posts in the message boards. He is also able to enable and disable user accounts. Only field researchers are able to input environmental variables. The chemical analysts are allowed to approve the data uploaded by the researcher. He/she is also responsible for managing the POP records.

A persistent organic pollutant system is intended for users to have a greater view of the risks involved in being exposed to POP's. Furthermore, the proposed system aims to aid authorities in overseeing the bioaccumulation of POP's by providing them of visual information about the pervasiveness of these pollutants in Metro Manila so that they could take measures to prevent its further transport. Legal issues are also of concern since authorities would be able to track excessive sources of emissions, if any.

VIII. RECOMMENDATIONS

Though the system is able to make predictions of the future levels of POP's concentration, it neglects transfer of pollutants from other areas and also disregards pollutants produced after the data's time of entry. The system would present more accurate data if a model that considers both of these would be used. Also, it would be better if that model would consider other environmental media, aside from air and soil.

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