Web-based mobile service for measuring parameters and estimating eutrophication of the Lake Prespa

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Abstract

Mobile Web Services are very useful and handy in many ways, especially in gathering and distributing a small, but very important amount of information. A specific task can be launch, such as measuring data from distance monitoring object, and sending specific messages about the state of the eutrophication for critical alarming values. In this paper we present the usability of Web-based mobile service in Ecology, for measuring main characteristic parameters and estimating eutrophication of the Lake Prespa. We have develop a mobile service that allows for online monitoring and retrieving data from an Information System database, that serves as a pollution monitoring system, and sending alarm messages for define critical measured values for estimated eutrophication state of the Lake. At the same time this mobile service must provide services for any kind of mobile device. To make this achievable, we have created this service in a .NET environment, which is very flexible and capable of adding new mobile web pages.

Keywords : *Lake Prespa, mobile, service, monitoring, eutrophication, messages, web server machine.*

INTRODUCTION

The eutrophication of the lakes has been established as a scientific fact since 1977 when, Carlson has provided methods to classified aquatic surface water bodies like lake, into three groups according to the level of the concentration for total phosphoru (TP), chlorophyll-a (Chl-a) and the secchi disk (SD) (Carlson et al., 1977). These three parameters are putting the lake into one of three groups in a scale of 0 to 100, oligothrophic lake; low productive lake, mesotrophic lake; medium productive lake and eutrotrophic lake; high productive lake.

Each of this groups has defined index as TSI, which is showing in which group is the lake. There are many methods to obtain Carlson Trophic State Index (TSI), but in this case we will use the empirical model (Kirchner and Dillon, 1975). Ecological models have proven to be very useful in solving ecological problems using computing technicians. Due to their ability to used little measured parameters to achieve their goal, the most successful ecological model that uses very little amount of such parameters for short-term prediction of the eutrophication of the Lake Prespa is this kind of model. To make this model functional, we have to measure the three main parameters, Concentration of TP, Temperature (Te) and SD, which will be used to calculate (TSI). TSI is the main indicator for the eutrophication of the ecosystems and encounters the relationship between the TP, SD and Chl-a, where concentration of the Chl-a will be automatically calculated. To achieve this goal, measuring and distributing the specific parameters, will be done using the Web-Based Mobile Service.

A similar mobile web service has been developed for Lake Ohrid (Mitreski and Stevkoski, 2003). The service was a fictional upgrade tool on the previously developed software. The Institute for Computer Science and Informatics at the Faculty of Electrical Engineering and Information Technology from “Sts Cyril and Methodius” at University in Skopje in cooperation with the Hydrobiological Institute from Ohrid developed a Web-based Information System (IS) for pollution monitoring of Lake Ohrid (Mitreski, Koneski, Naumov ad Davcev, 2002). This application was based on pollution data acquisition unit, database processing sub-system and GIS processing unit (Mitreski, Davecv, Jordanovski and Naumoski, 2002). Using the Web-based mobile service, the data and analysis is performed on one place and are available to any user having only mobile device (Mitreski and Stevkoski, 2003).

The main contribution of the web based mobile service, presented in this paper, is to provide an architecture for essential notification via mobile web page, about the eutrophication status of the Lake Prespa, using collected measured data for the stations, which is inputed into the IS database and later by request, present to the mobile user.

All this knowledge in the Knowledge Base (KB) for the specific restrictions, or rather to say limitations of the measured values will be incorporated into the KB. This paper is organized as fallows. Section 2 gives the general model of the web-based mobile service, while Section 3 more closely describes the functionality of the Knowledge Base structure. The complete description of the implementation details, with presentation of the desktop application and the mobile service is given in Section 4, while section 5 concludes the paper.

GENERAL MODEL OF THE MOBILE SERVICE

Web-Based Pollution Monitoring System

The web-based mobile service is a developed on a previously IS for pollution monitoring system (PMS). The structure of the PMS includes three general levels, data acquisition level; Read, data handling level; Write, management level; Search.

The Data acquisition level of the PMS is responsible for gaining general information about, the lake itself, its rivers and its monitoring stations, specific measurements taken from the monitoring stations, water status of the lake and its rivers. In our research, the part for gaining general information about the lake and the measured parameters will be considered.

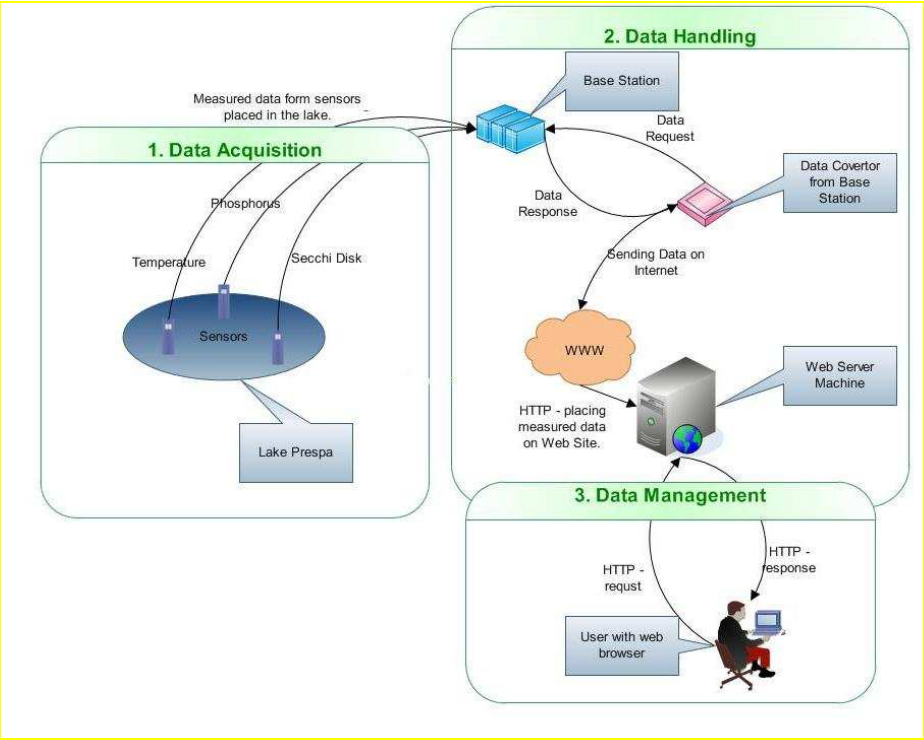

Figure 1. Web-Based Pollution Monitoring System for Lake Prespa.

Furthermore, the data handling level of the PMS involves entering, updating and deleting of the above mentioned data into and from the created database. The system is divided in two parts, administrator and user.

The third level of the PMS is the Management level. At this level the presentation data is analyzed by the system next it is distinguished, selected and ordered and finally it is presented by the user. Data can be managed only from system or managed by both the system and the user. All this three level are shown (on Fig.1).

The PMS is divided into two parts, user and administrator. This division was determined in the analysis phase of the project since the need of manipulation with data was stated in the user requirements for the system solution.

2.2. General model of the Web-Based Mobile Service

The general model that which is presented into this paper, is yet not implemented, so we will give only the usability of this kind of mobile service. As object for monitoring, in our case study is Lake Prespa, which monitoring stations are deployed as a part of the TRABOREMA project (TRABOREMA, 2005-2007).

The Web-based mobile service which schematic diagram is presented (on Fig.2) is consisted from four main parts. All of the components that are needed to present the relevant eutrophication status of the Lake Prespa are built using .NET technology. The sensors that are measuring the critical parameters are placed in different locations, mainly in coastal region, shown with green border; object for monitoring. Measured data for the temperature, concentration of phosphorus and the secchi disk, are distributed to the Base Station.

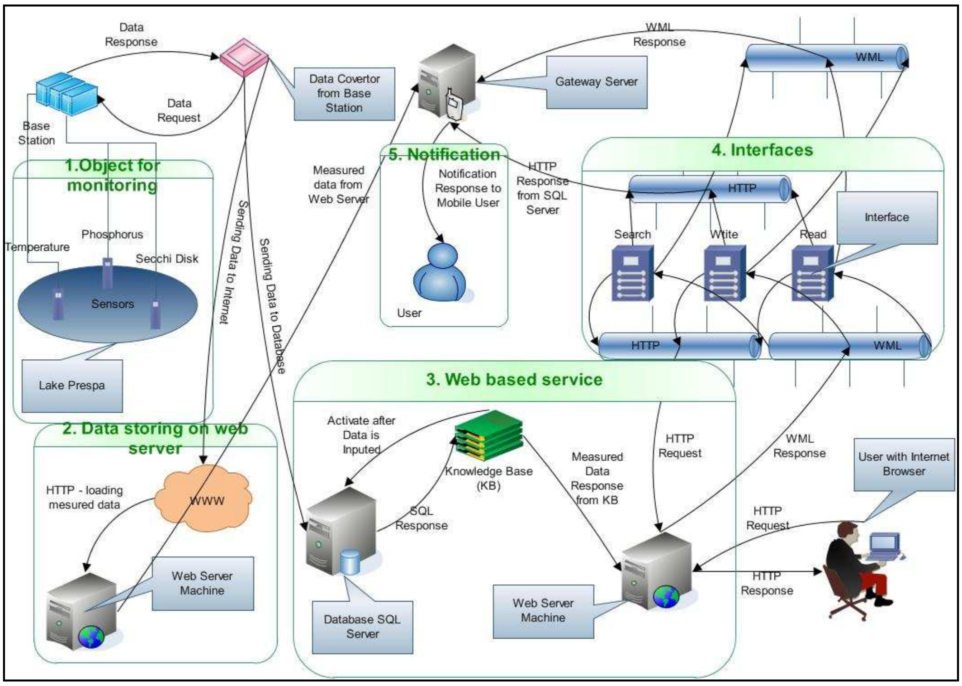

Figure 2. Schematic diagram of the Web-based mobile service for Lake Prespa.

But, they are not yet compatible to be placed immediately on the web, so we use data convertor that sends data request and gets data response from the base station. After conversion, measured data it can be is sent to World Wide Web (WWW) and then store into Web Server Machine (WSM); Data storing on web server or it can be store into Database SQL Server, which main objective is to collect and maintain measured data; Web based service. Later we will focus in the database, which is connected with the KB. The KB is the hearth of the Web-based service that gives us the intelegance to calculate the eutrophication of the Lake Prespa. After data is processed into the KB, then it is sent to WSM, and later distributed to mobile user, or to a user that uses only a web browser, with Hypertext Transfer Protocol (HTTP) response and request. Distribution of the data to the mobile user is enabled by using WML request and response, and special design of the mobile web pages or interfaces; Interfaces. Globally we have three kinds of interfaces, one for reading data and distributing the eutrophication status of the Lake, second one is for inputting special command and one for searching specific data. Then using a gateway server, the messages with request contents is send to the mobile user, how is having only a mobile device; Notification.

To estimate the eutrophication status, in the next section we will take closer look on the process inside of the KB.

3. KNOWLEDGE BASE

After the measured data is gathered from the monitoring stations and distributed to the database, a process that activates the KB takes place. (In Fig.3) we can see the action diagram that is responsible for estimating the TSI, and later this status is send to the mobile user (William L. Oellermann et al., 2007).

From the measured data, the TP and SD values are selected and then used to calculate chl-a, according equation (1).

$$Chl - a = 2{,}45 * P^{0{,}31} \qquad (1)$$

Then the web service takes this value and calculates the TSI, according Carlson equations (TRABOREMA, 2005-2007). As we said before, the main question arises from the task we have, and this question is processed by the web service.

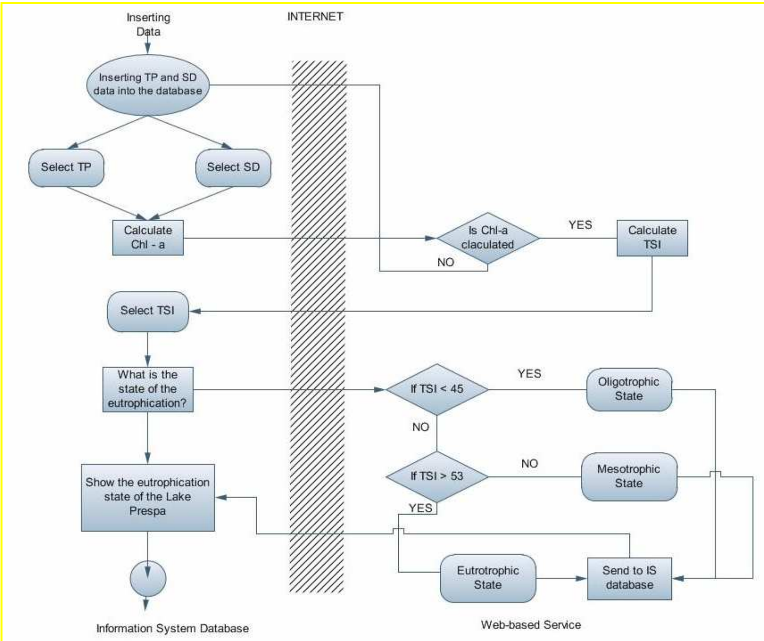

Figure 3. Action diagram that represents the process inside of the Knowledge Base.

After the answer is gain and the Lake Prespa is places into one of the three groups, the web service sends this information to the IS database and response to the mobile user. Then the status of eutrophication will be shown on the mobile web page on specific interface.

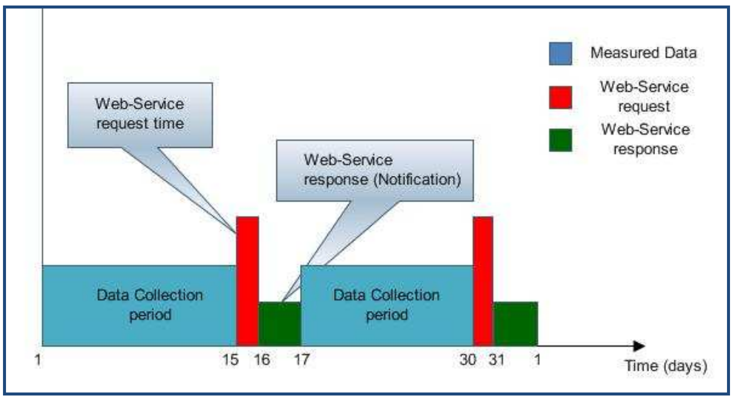

Figure 4. Web service response and request time period.

It is important to get the information correctly and with certain time accuracy. According to the OECD standards the lake should be monitored at least once per month (OECD, 1982). During the summer season the monitoring should be performed twice a month. (On Fig.4) we have represent the time needed for request and response operations of the web service.

The time period that is need for request and response, for fast internet connection and high-speed web servers can be reduce in minutes, even in seconds. However, in that case, the user might experience the information overload. Since the time period needed for data collection is twice a month, we can relay to the one per day update on the web server information.

IMPLEMENTATION OF THE MOBILE SERVICE

Presented Web-based Mobile Service in section 2, is not yet deployed, but some of his parts, like monitoring stations and distributing data to certain WSM that is shown (on Fig.1) is constructed and implemented. After measured data is placed on the WSM, it can be provided a suitable interface for the given operation. The service composed from three parts. The first part can be used by authorized personal only and it gives them means to insert data to the IS database. Before using this tool, the user must provide username and password that is checked in the database, and the software will grant or deny access to this resource (Mitreski, Davecv, Jordanovski and Naumoski, 2002).

This is a write operation shown as write interface (on Fig.2). After acknowledgement, the service takes us to a page where the users can choose a parameter to insert, including the parameters value, monitoring station as well as the date and time of measurement, (as is shown on Fig.5).

The other part of the mobile service, allows users to read and search certain measured data from the IS database. This part of the service is free to access by any user to the database, who needs to monitor and analyze the pollution of the Lake Prespa, in a manner to be informed with newly collected data. The database can be queried on any of the three parameters, for any of the monitoring stations, as well as for a wanted period of time. This is a read/search operation shown as read/search interface (on Fig.2).

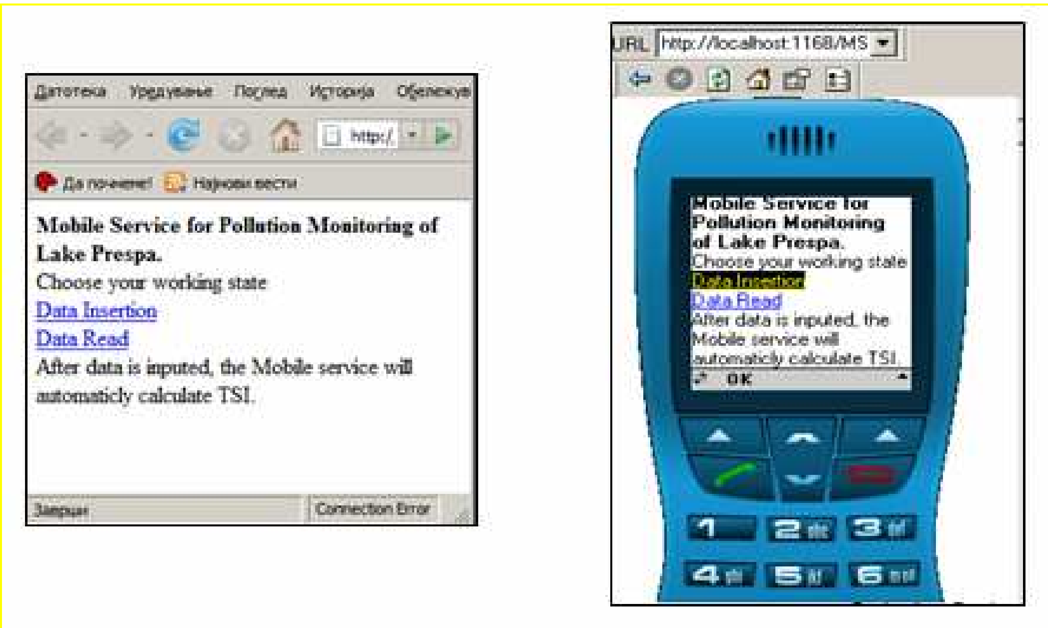

Figure 5. Insertation of the parameters to the database information system using web browser and the mobile service.

The last part is consisted from a notification message service to the mobile user that will notify the user for the eutrophication status of the lake. Based on equation (1), the mobile service automatically calculates the TSI, and then distributes to the decision-maker.

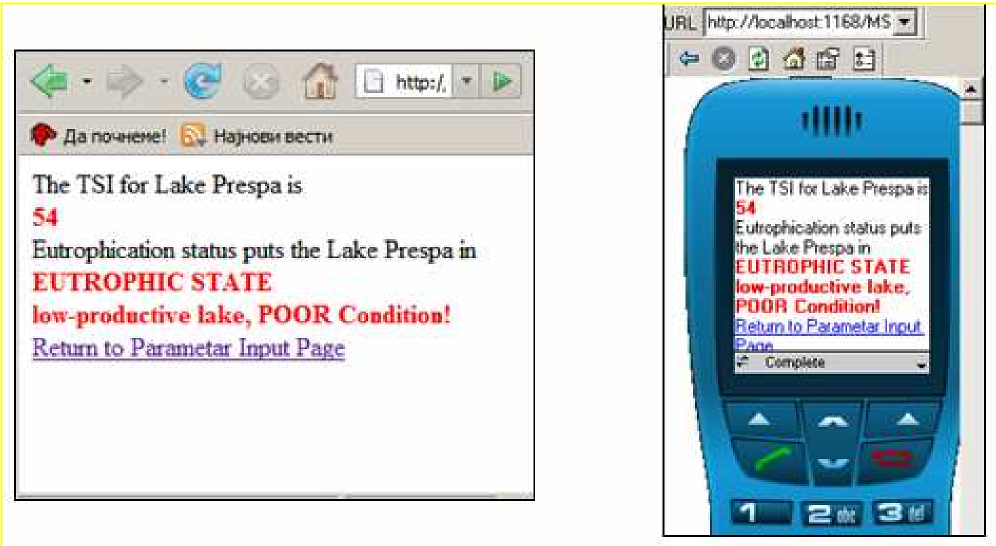

Figure 6. Notifying the user for estimated TSI and eutrophication status of the Lake Prespa.

The web page that is presented on the mobile device of sending and receiving this eutrophication status information, using web browser and mobile service (Fig.6), respectively. This notification to the mobile user; Notification, (is shown on the Fig.2).

CONCLUSION

The paper demonstrates a usability of Web-based Mobile Service using .NET technology and knowledge from ecological modeling for estimating the eutrophication status. The system consist from four components: a monitoring object, in our case Lake Prespa, IS for pollution monitoring with integrated Server database, the mobile web service and the user with define specific interfaces. The technology needed to be develop this service is available, and it can be greatly support all parties involved in pollution monitoring for decision making including water waste management system, local communities, and state government agencies. When integrated, spatial information and relevant technologies can be utilized to improve the efficiency of water waste management activities and to make more objective.

The direct benefits for the decision makers comes from ability to estimate the eutrophication status in discreet periods of time and later then use to analyze it's future trend and then estimate the dynamic of the ecosystem. Because the temperature parameter is also estimated, using the mathematical modeling with differential equation that involves different biological and chemical processes, in the future work we will be able to simulate and then provide future estimation of the ecosystem and predict the level of eutrophication for long-term period (TRABOREMA, 2005-2007). These futures can be implemented using the flexibility of .NET with creating different web pages for mobile devices. Although our system has been developed for Lake Prespa, it can be adapted and employed in other lake areas.

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