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Pollution monitoring system for the Lake Ohrid - a planning scheme

K. Mitreski*, D. Davcev*, M. Jordanoski**, T. Naumoski**
**Faculty of Electrical Engineering, Karpos II, 91000 Skopje-Macedonia*
E-mail: komit@cerera.etf.ukim.edu.mk
***Hydrobiological Institute of Ohrid, Naum Ohridski 50, 96000 Ohrid-Macedonia*

Abstract

In this paper we will present our scheme for planning the Pollution Monitoring System (PMS) for the Lake Ohrid. Lake Ohrid is included on the UNESCO World Heritage List, because of it's age and unique life. Our objective is to establish an integrated monitoring system which will allow an assessment and future control of the water quality. The structure of the PMS will include three levels. After presenting the plan of water quality PMS, selection and position of measurement points, we will give the first experience in using this system.

1 Introduction

Eutrophication, which may be natural or "man made", is the response in water to overenrichment by nutrients. "Man made" eutrophication, in the absence of control measures, proceeds much faster than the natural phenomenon and is one of the major types of water pollution[1]. Therefore, an adequate pollution monitoring system is necessary in order to improve the water quality to the standard required for its intended use. Assessment of the total nutrient load is a crucial problem, especially the estimation of the total phosphorus load [2].

A Dynamic Integrated Monitoring System (DIMS) is presented in [3]. Monitoring is based on on-line measurements, laboratory analyses on different types of samples, information on raw materials and products etc. One of the main objective of DIMS is to provide an active monitoring and effort for protection of the environment. The system is designed to handle acute pollution situations and to give the prognosis of the load compared to the standard limits.

In [4] the trophic status of the Tolo Harbour based on the monitoring stations results obtained from the Hong Kong Government with particular reference to the chlorophyll- a, secchi depth, total nitrogen (TN) and total phosphorus (TP) concentration is given.

As a part of our PMS, we developed a mathematical model for phosphorus concentration estimation [5]. Mathematical modelling can contribute to improve understanding of the lake behaviour and to provide better understanding of the ecosystem [6], [7]. The model is mainly based on the general Vollenweider model [8].

The concentration of the dissolved inorganic phosphorus has been modelled by a simple two-box model in [9]. We adapted the existing models regarding the specifics of the Lake Ohrid coastal region.

In this paper we present our scheme for planning the PMS for the Lake Ohrid in Macedonia (see [5] for the basic characteristics of the lake). Our objective is to establish an integrated system which will allow an assessment and future control of the water quality. The structure of the PMS will include three levels.

The paper is organized as follows. In section 2, the plan of water quality PMS is presented. In section 3, selection and position of the measurement points on the Lake Ohrid is given. The preliminary experiance in using our PMS will be discussed in section 4, while section 5 will conclude the paper.

2 Planning of water quality monitoring

The basic structure of the PMS includes three levels:

-Data acquisition level responsible for systematization, validation, comparison of data with alarm limits and creation of dynamic part of the relational database system; the static part of the database with information about standards,limits, models etc.

-Data handling level responsible for supervisory control and specialized data analyses and model evaluations; it's also responsible for integration of on-line with off-line information to make statistical reports and data presentation.

-Management level which is responsible for short term decisions and long term strategies for the pollution reduction approach.

In this paper, we will consider only the first level.

The scheme for planning of water quality monitoring is shown in Fig.1. The analyses should include the basic water quality items and any others which are required for the present and future use and are present in significant concentration. Preliminary survey on water quality was performed by Hidrobiological Institute of Ohrid since 1950 on the monthly basis. To monitor the degree of eutrophication, the measurement of phosphorus is essential [9]. The phosphorus is closely related to the biological activities in water. The eutrophication is generally discussed based on the concentration of phosphorus.

When the sampling and analysis begin, the data obtained should be feedback to those responsible for water quality monitoring. After a suitable period, there should be an examination of data determined to decide whether or not the water quality parameters,

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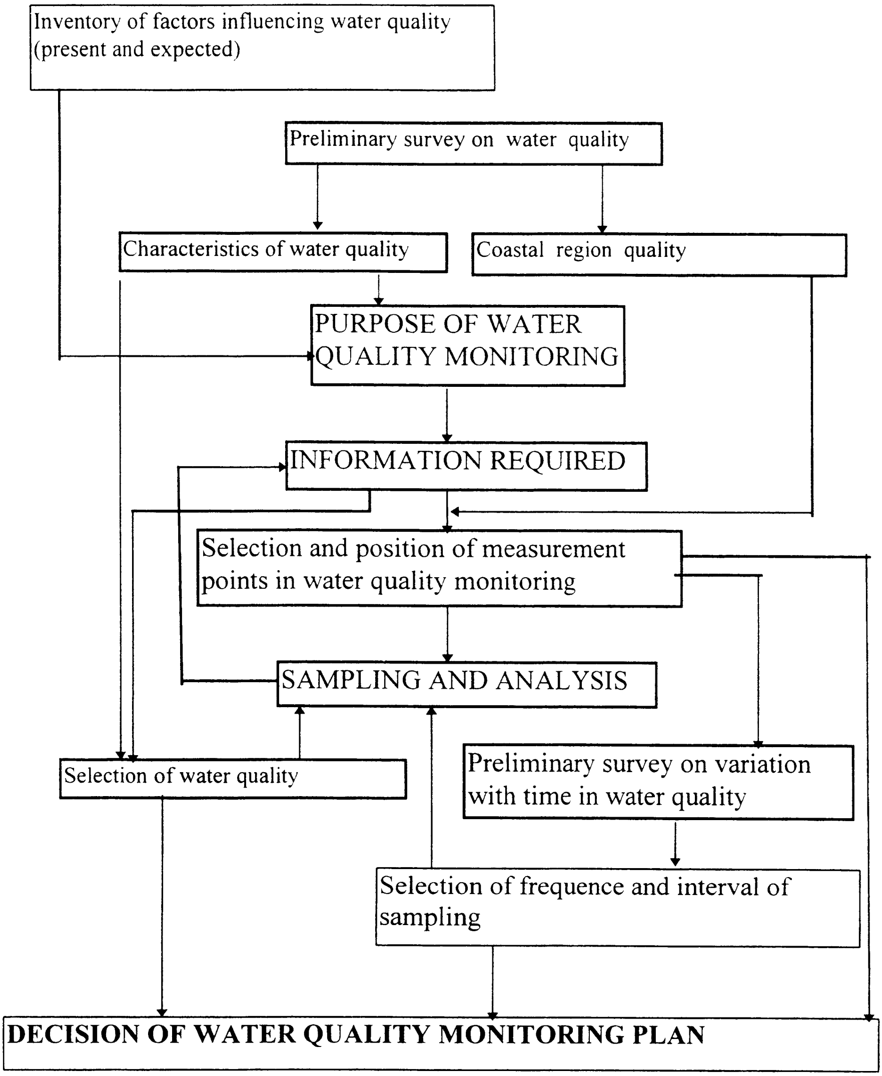

Figure 1: Scheme for planning of water quality monitoring

stations or points, and frequency (interval) of sampling are meeting the information requirements. Consideration should be given to any changes in the water quality parameters, sampling locations, sampling frequency (intervals) which might improve the values of the data. As a support of these activities we plan to establish a hardware and software configuration of our PMS as presented on Fig.2.

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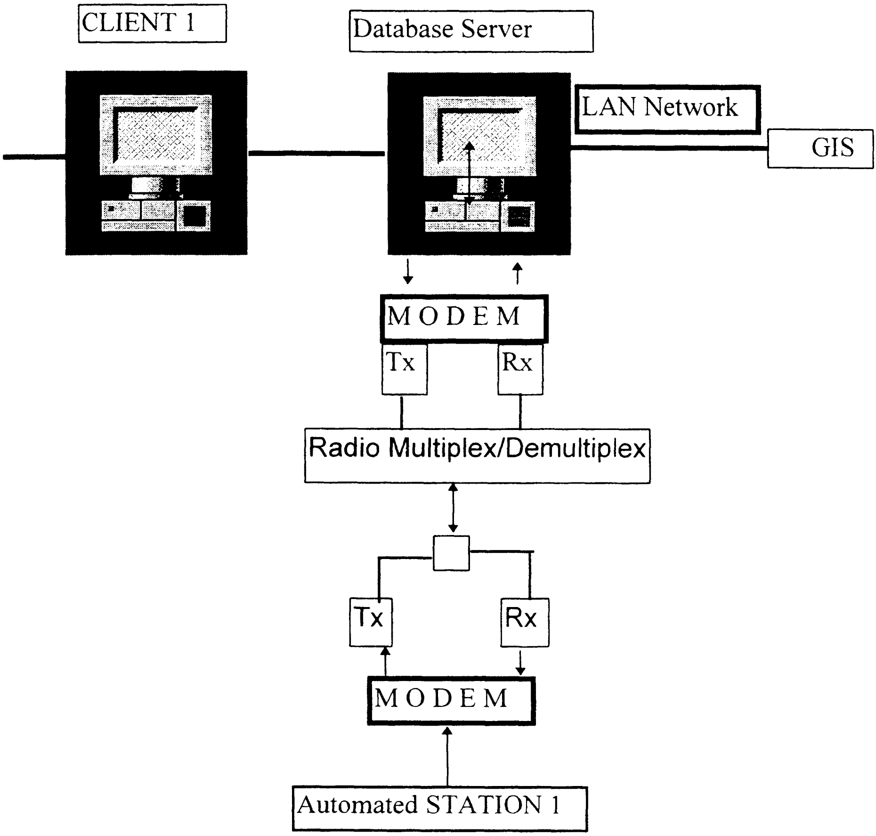

Figure 2: Hardware configuration of the PMS

A microprocessor based stations continuously control the function of the automated analyzer and calculate concentration from the signals of the sensors. This method is very quick, and the measured value is available within 2-3 minutes after concentration change at the input of the analyzer. The necessary cleaning solution and distilled water are placed in the analyzer.

3 Selection and position of measurement points

Our PMS consists of 6 measurement points along the coast of Lake Ohrid and 4 measurement points along the rivers as shown on Fig.3. The lake water samples were collected each month in a period from January 1996 to January 1997. Computer based monitoring of water quality includes several parameters: temperature, electric conductivity, pH, dissolved oxygen, biodegradable organic matter, total phosphorus etc.

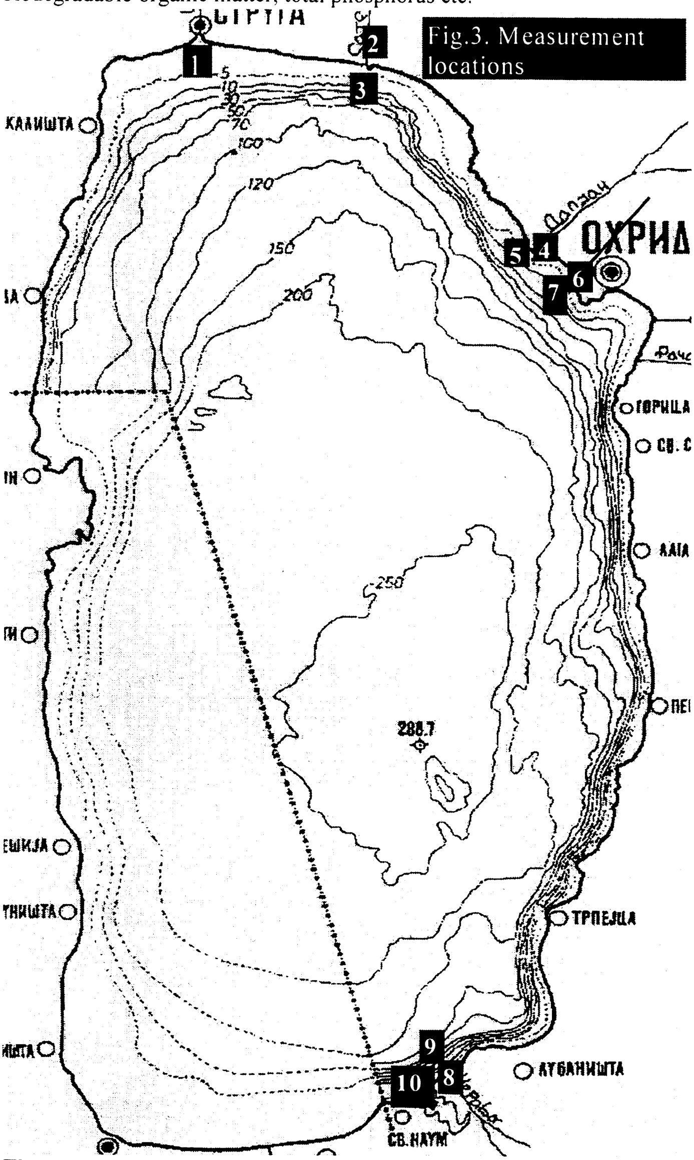

Fig.3. Measurement locations

The measurement point: 1- Output - River C.Drim 2-River Sateska; 3-Littoral R.Sateska; 4-River Daljan; 5-Littoral R.Daljan; 6-River Velgoska; 7- Littoral R.Velgoska; 8-River Cerava; 9-Littoral R.Cerava; 10-Input St.Naum

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loc./mon.	Jul./96	Aug.	Sep.	Oct.	Nov.	Dec.	Jan./97	Feb.
1	21	22.5	19	17	12.8	9.5	6.5	5.7
2	16.5	19.6	14	13	9.6	6.4	5.2	4
3	21	23.7	19	17	11.3	6.8	6.6	4.7
4	14.8	14.2	14	13	10.5	8.1	7.2	4.8
5	21.6	23	19	17	13.4	9.2	7.4	7.5
6	16.5	17.6	14	15	10.7	8.4	7	4.7
7	18	23.8	19	17	13	10	7.4	6.5
8	20.9	19	15.5	15	12.8	6.9	5.1	3.1
9	22.1	21.8	20.5	15.8	13.8	9.6	7.9	8
10	11.5	11.2	11.8	11	12.8	11	10.7	11.1

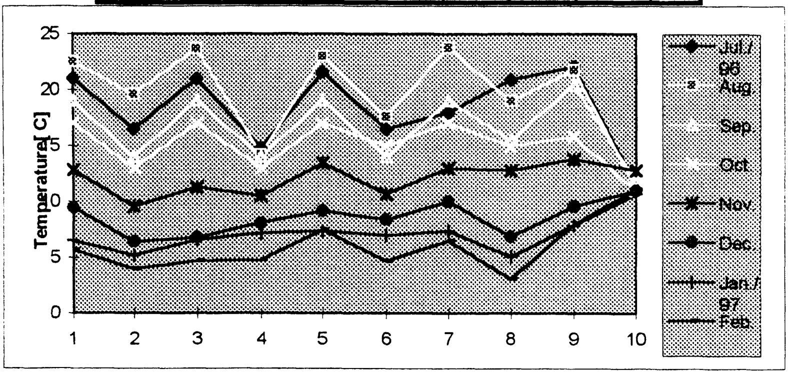

Fig.4

loc./mon.	Jul./96	Aug.	Sep.	Oct.	Nov.	Dec.	Jan./97	Feb.
1	0.2	0.2	0.78	0.2	0.57	0		
2	0.22	0.54	0.33	0.71	1.23	0.62		
3	0.43	0.32	0.38	0.31	0.55	0.08		
4	0.55	0.54	0.78	0.59	3.26	0.11		
5	0.62	0.27	0.66	0.2	1.09	0.04		
6	12.38	25.03	20.9	25.57	25.14	15.4		
7	4.14	2.62	1.71	3.76	2.14	0.08		
8	2.29	12.21	4.33	0.51	1.76	0.085		
9	0.33	1.04	0.7	0.33	0.77	0.62		
10	0.49	0.34	0.45	0.29	0.6	0.23		

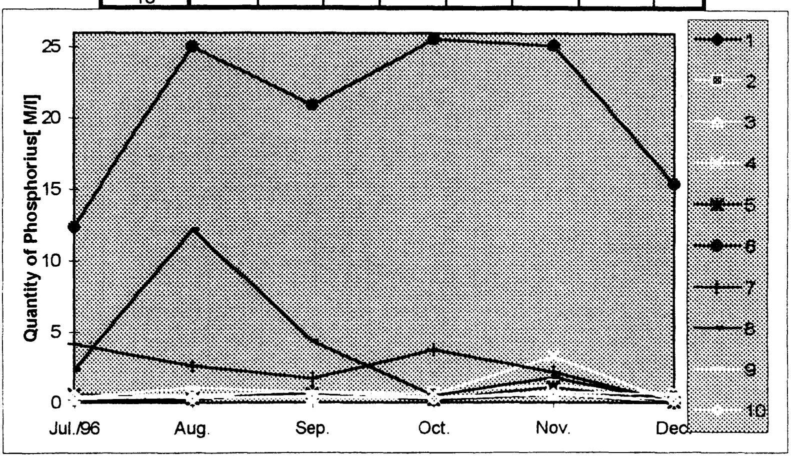

Fig.5

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4 Results of preliminary measurements

On Fig.4 and Fig.5 the measured values for temperature and phosphorus concentration are given respectively. It is evident that the highest concentration of phosphorus is present on the measuring point No.6 (River Velgoska).

5 Conclusion

In this paper, we presented our scheme for planning of our PMS for Lake Ohrid on the first level. On the basis of this planning activities we determined the measured points on the Lake Ohrid. We also presented some of our preliminary results. We plan to provide the measurement results for other parameters as well. On the basis of these measurements and activities we will be able to upgrade our PMS on level 2 and 3.

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