RiverPrut - SOFTWARE FOR DETERMINATION AND MANAGEMENT OF WATER QUALITY

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INTRODUCTION

Water quality is a primary problem for every country's sustainable development. Nowadays there is a continuous process of water quality degradation in the majority of regions around the world. To stop this process, complex studies and actions are needed to be initiated by specialists from various fields.

Water quality has diminished dramatically as a result of human activity. Water quality evaluation of several bodies of water in Europe, according to the requirements of the Water Framework Directive, denotes a satisfactory or unsatisfactory environmental status. In order to rehabilitate and maintain water systems in a "very good" condition [1], there is a need of a thorough analysis of them.

In the majority of cases, water from rivers is used for human necessities such as water supply, irrigation, power generation etc.

Water quality is increasingly being influenced by pollution with various chemical, physical and biological substances. According to specialty literature, there are multiple analytical methods of determination of water quality, depending on the parameters and standards set out in the field. Usually, these methods include: parameter selection, adjustment of measurement units to the same scale, weight establishment of each parameter, water quality index calculation and others [2, 13-15].

An important criterion for water quality determination is the ratio of the amount of substance discharged and the normative limit of discharges. This is described by the Water Pollution Index (WPI), which value is calculated according to a fixed number of parameters (6): ammonium nitrogen, nitrite nitrogen, petroleum products, phenols, dissolved oxygen, biochemical oxygen for each 5 days. WPI is calculated according to the following formula [3]:

$$WPI = \sum \frac{C_i}{MAC_i / 6} \qquad (1)$$

where: $\boldsymbol{C_i}$ – average concentration of parameters, $\boldsymbol{MAC_i}$ - maximum admissible concentration of parameters, 6 – number of parameters taken into account.

1. A SHORT DESCRIPTION OF THE SOFTWARE

Mathematical modeling and numerical modeling are essential tools for water quality class calculation, as well as for determination of spatio-teporal evolution of pollutants for the purpose of preventing exceptional situations. Proper choice of the mathematical model and and simulation program allow a proper assessment of water quality [4, 5, 8-10].

According to bibliographical sources examined, at present there are several attempts and proposals of water quality modeling in rivers. These papers suggest variuos approaches to mathematical model combinations, GIS systems and software techniques [6, 7, 9, 11, 12].

RiverPrut, a software for determination of water quality class according to WPI, was created using Java programming language. The logical scheme of the program is presented in the Fig. 1.

RiverPrut software allows users to determine water quality of the Prut River according to WPI values, in each sector examined. The main window of the program is presented in the Fig. 2. At the top it is situated the scale of water quality classes, correlated with respective colors. In the upper right corner there is a drop-down list for the selection of the year of data to be presented. In the left part there are eight buttons – corresponding to studied sectors and a button with the image of Prut River map. Depending on the occurred event (year or sector changing), the color that indicates respective water quality class of the sector is initialized according to WPI.

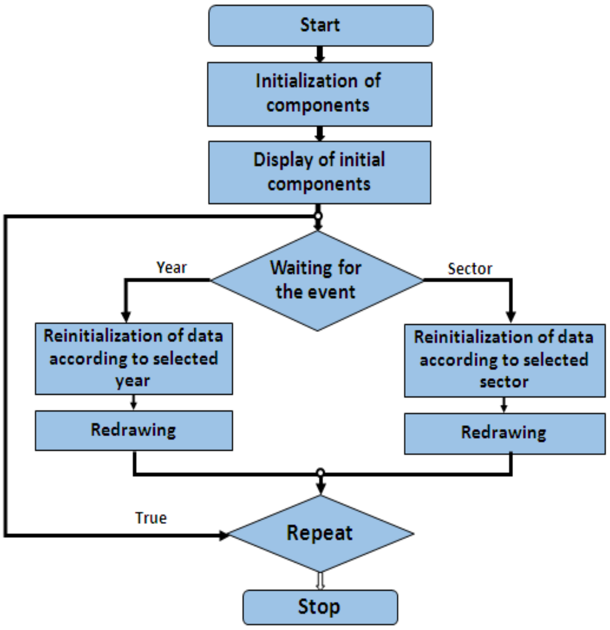

Figure 1. Logical scheme of the software.

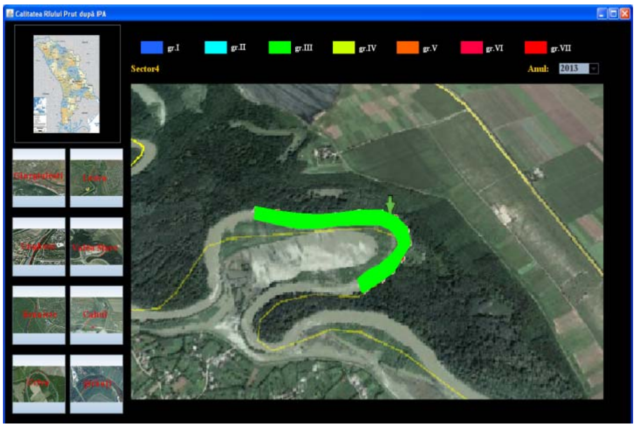

Figure 2. Water quality in the sector of Prut River from Valea Mare locality in 2013.

II. CASE STUDY - APPLYING SOFTWARE FOR RiverPrut WATER QUALITY DETERMINATION

The developed software was applied for determination of water quality in the Prut River. WPI values were examined for eight sectors of Prut River: villages Criva, Şirăuţi, Branişte, Valea Mare, Giurgiuleşti; cities Ungheni, Leova, Cahul –Fig 3. Information about WPI was provided by the State Hydrometeorological Service. From Fig. 3 it can be observed that River Prut water quality in Criva locality for the 2009-2011 period and 2013 year was placed in the second class(clean), and in 2012 year in the third class (moderately polluted); water quality in

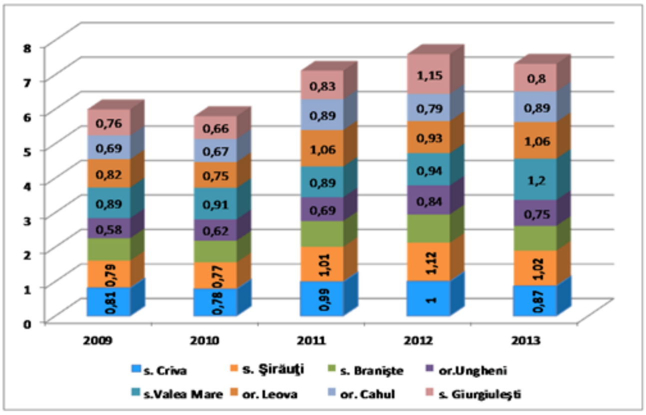

Figure 3. WPI values for the examined sectors of the Prut River.

Şirăuţi in the 2009-2010 period was placed in the second class(clean) and in the 2011 – 2013 period in the third class(moderately polluted); in Branişte and Ungheni localities it was placed in the second class (clean) for the entire 2009-2013 period; in Valea Mare and Leova it was clean for the 2009-2012 period and in 2013 moderately polluted; in Cahul locality, for the entire examined period, it was clean; in Giurgiulesti water quality was placed in the second class(clean) for the 2009-2011 period, in 2012 – in the third class(moderately polluted) and in 2013 – again in the second class(polluted).

Water quality in Şirăuţi locality in 2013 year can be observed in the Fig. 4.

Figure 4. Water quality in the sector of Prut River from Şirăuţi locality in 2013.

It is possible to view the water quality in the entire sector of the Prut River on the territory of Moldova by accessing the picture of the Prut River and selecting the option Year. This allows to monitor the water quality in the entire Prut River and to undertake proper management of water quality. For example, the water quality in Prut River in 2012 year is presented in the Fig. 5, and in the 2013 year – in the Fig. 6.

Figure 5. Water quality of Prut River in 2012.

Figure 6. Water quality of Prut River in 2013.

CONCLUSIONS

Water quality based on WPI was determined in the river-type systems by designing and creating a software program for this purpose – RiverPrut. This will allow to actively and rapidly store information about water quality.

The water quality based on WPI was determined in 8 sectors of the Prut River. According to the results of analysis it can be affirmed that for the majority of analyzed sectors water quality falls within the second class (clean) and only in some cases and for some sectors it is moderately polluted.

The software that was created can be customized for other river-type systems, by changing configuration files, sector names and map. Also, the system offers a tool for determining the coordinates of river sector polygons on the map, which can be used to determine the coordinates for any other sectors and rivers.

It has been observed that the mathematical model is useful if the water quality is examined during a longer period of time, minimum 5 days.

If analyzing water quality daily, then it is necessary to model turbulent water flow in river-type systems and, accordingly, pollutant transport and dispersion processes.

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